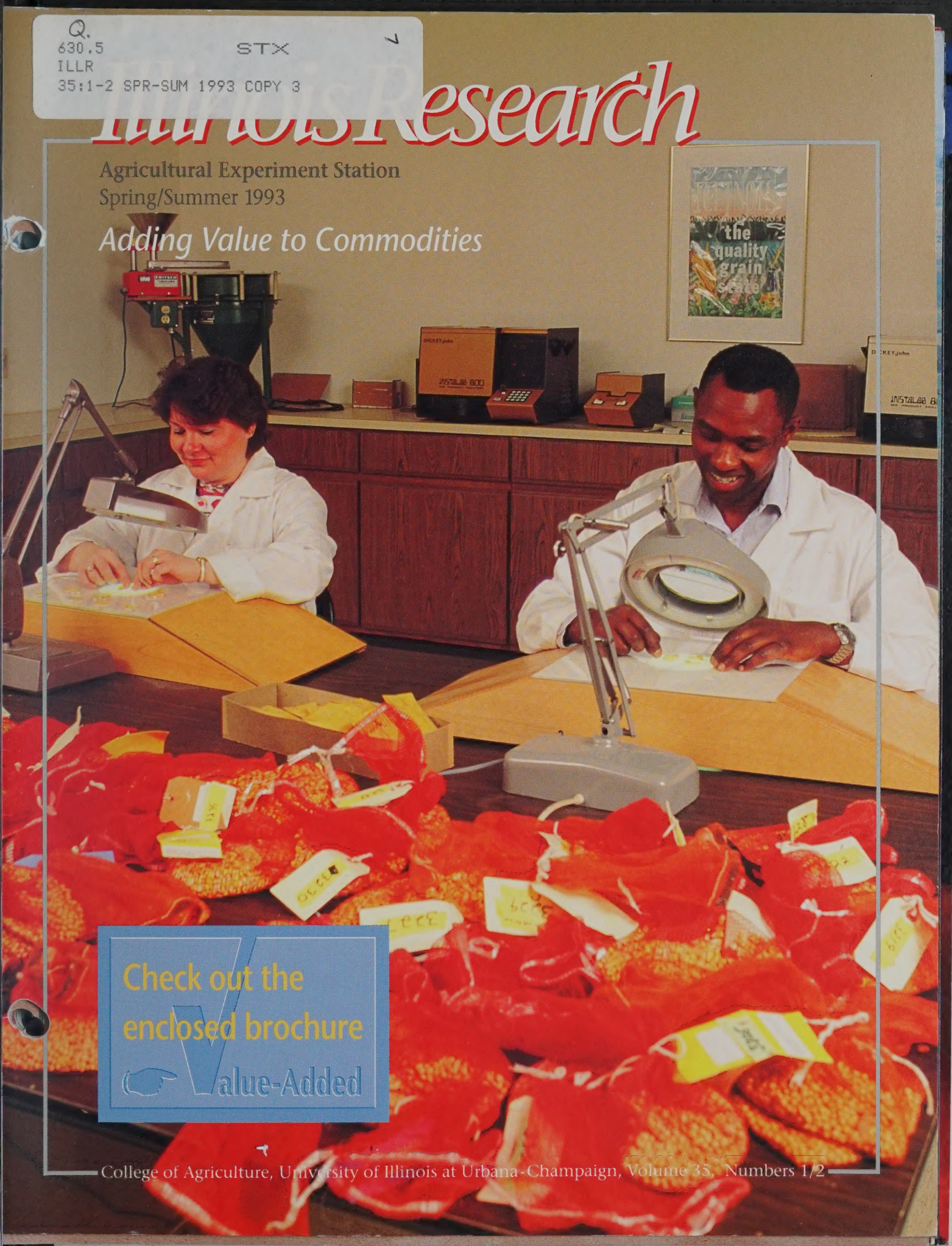
Illinois Research

Agricultural Experiment Station
Spring/Summer 1993

Adding Value to Commodities



Check out the enclosed brochure
Value-Added

College of Agriculture, University of Illinois at Urbana-Champaign, Volume 35, Numbers 1/2

The Cover

Lab technician Debbie Bialeschki (left) and supervisor Steve Mbuvi inspect corn for stress cracks and horneous endosperm at the Identity Preserved Grain Lab in Champaign, Illinois. *See page 11.*

Illinois Research

Spring/Summer 1993
Volume 35, Numbers 1/2

Published quarterly by the University of Illinois Agricultural Experiment Station

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Adding Value

Creating Value in Agriculture

Agriculture transforms carbon dioxide, nitrogen, water, and various mineral nutrients into food, feed, natural fiber products, and renewable sources of fuel and chemical feedstocks. The end results are nourishment, shelter, clothing, comfort, adornment, and, if other conditions are met, physical, mental, and emotional well-being.

At each stage of the agricultural process, value is added, hence the expression *value added*. Each stage requires inputs, including labor, capital items (land, buildings, facilities, and equipment), and management.

In pioneer days, farmers performed all the steps in the value-added process. They were the producers, processors, distributors, and retailers of agricultural products. Because most of the population farmed, farmers were also the principal consumers of agricultural products.

Pioneer farmers supplied almost all the necessary inputs and support services. They hauled some of the produce to town, often marketing it directly to their city neighbors. Through the farmers' institutes and similar organizations, they shared agricultural information with each other.

The most significant change in U.S. agriculture has been a great division of labor and a high degree of specialization within the agricultural process. Now, each step in the process involves different individuals and groups.

These include producers, processors, distributors, retailers, and consumers. Supporting each of these groups are financial institutions, suppliers, equippers, builders, transporters, consultants, farm and trade organizations, branches of government, government agencies, land-grant universities and their colleges of agriculture, other institutions, and the media. It is the same basic process as in pioneer days, but enormously more complex.

For example, to produce and consume a hot dog requires producing and consuming a number of intermediate products, including inbred seed corn, hybrid seed corn, soybean seed, corn, soybeans, feed, swine breeding stock, feeder pigs, fattened pigs, pork, wieners, and, the final product, hot dogs. In the language of economics, each intermediate and final product represents an "economic stage," a link in a long "value chain."

Actually, the situation is even more complicated. There are other value chains and economic stages involved in the corn to hot dogs process. These include chains producing inputs, such as fertilizer for corn and soybean production, vitamin and mineral supplements for animals, non-meat ingredients of wieners, and buns for hot dogs.

There are value chains leading to utilization of coproducts or byproducts associated with each of the intermediate products. To put it another way, there are several converging and diverging branches of the value chain linking corn and hot dogs.

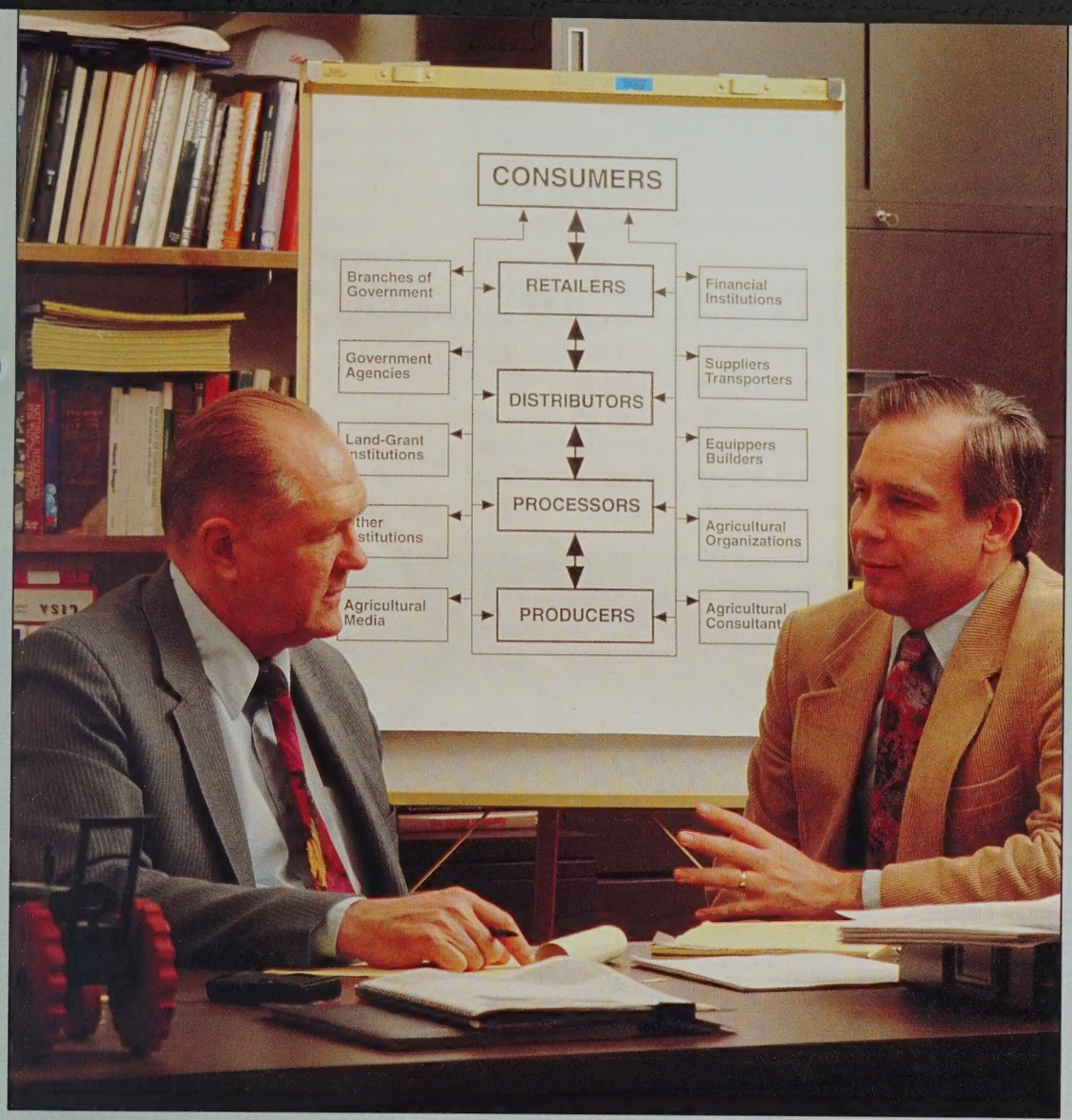
To portray accurately the enormous complexity of the value-added process, we would also have to describe the research and development (R&D) efforts that feed information and technology to each stage. These R&D programs are extremely complex value-creating processes in themselves.

Some liken successive economic stages to a river and refer to "upstream" and "downstream" processes. In our example, growing corn is upstream and processing meat is downstream from feeding pigs.

Others view agriculture as a vertical process, starting at the bottom and moving upward through economic stages of increasing value, culminating in the value realized by the consumer of agricultural products and services. This leads to the expression *vertical integration*, which occurs when two or more stages are accomplished by one agribusiness firm.

Two or more economic stages in agriculture may be accomplished through close cooperation and coordination between two or more agribusiness firms. To distinguish this from vertical integration, the phrase *vertical cooperation* is used. The cooperating firms may collectively be referred to as a *value-added partnership*.

Now it is common for seed companies to contract with farmers to produce certain crop varieties or hybrids. In the future, it will not be uncommon for all the firms in a value chain to be organized by contracts into a value-added part-



Don Holt, left, and Steve Sonka discuss the complexities of the modern-day value-added process.

nership. The role of these contracts and other similar mechanisms will be to achieve better "market coordination." Different value chains and products will require different degrees of organization and coordination.

R&D people and their organizations will be important members of these value-added partnerships. Not only is the agricultural process that leads to differentiated products more complex than traditional agriculture, the R&D process by which those products are developed is more complex also.

A research effort leading to a differentiated product must deal with all the economic stages involved in producing the final product. It must also include all the research and development functions — including basic, developmental, and adaptive research — and technology transfer.

There will often be not only scientific and technical but also economic, social, legal, political, and perhaps even religious constraints to commercializing a new product. All of these will have to be addressed in the R&D effort.

To meet "time-based competition," that is, to produce improved products sooner than competitors, the R&D functions will be conducted simultaneously instead of sequentially. R&D programs supporting highly coordinated markets will be integrated over economic stages, R&D functions, and disciplines.

Partners, including the research and education partners, in each value-added initiative will need to be in constant communication. Advanced information technology, including communication networks, will be essential to greater market and R&D coordination.

If we manage it well and integrate it well with similar efforts in the rest of the industry of agriculture, our value-added research and education effort at the University of Illinois will illuminate a path into the agriculture of the future. We hope you will find this issue of *Illinois Research* exciting as it reveals new and improved agricultural products and processes along that path. — *Steve Sonka, professor, Department of Agricultural Economics, and Don Holt, director, Agricultural Experiment Station*

Value-Added

Turning Crops into Plastic...and Cash

Larson B. Dunn, Jr.

Plastics, or more properly, synthetic polymers, have been commercial products since the dawn of the twentieth century, and they continue to grow in popularity. Leo Bakeland patented his phenol-formaldehyde polymer, which he called Bakelite, in 1909. By 1991, a form of Bakelite was being widely used as a wood adhesive in structural panels, with domestic production exceeding 2.6 billion pounds. World War II provided the impetus for the rapid development of other synthetic polymers such as Plexiglas and synthetic rubber. The combined domestic production of synthetic polymers such as polyethylene and polypropylene exceeded 29 billion pounds in 1991.

Most of these common synthetic polymers incorporate petroleum-based chemicals. However, environmental concerns about these non-renewable products have led to interest in polymers that are based on biodegradable and renewable resources, such as corn and soybeans. UI research has been integral in developing these technologies that could greatly increase the value of Illinois field crops. Departments in the College of Agriculture continue research that will make these technologies more economically attractive to polymer manufacturers.

Polyethylene, polypropylene, and polymethyl methacrylate (Plexiglas) are classified as thermoplastic polymers because they soften, or become plastic (pliable), when heated. The use of the word *plastic* to describe all synthetic polymers arises from the term *thermoplastic,* though the term is just one of many used to classify these polymers. For example,

Larry Karcher, graduate student in Food Science, tests wood adhesives made with starch-based chemicals.

polymers from phenol-formaldehyde are called *thermoset* polymers because they become permanently hard and rigid when heated. Polystyrene-butadiene (synthetic rubber) is termed an *elastomer* because it can be stretched many times its original length and return to its original shape — it is elastic.

Polymer Problems

One of the earliest perceived problems with many of the synthetic polymers was their lack of stability or longevity. However, heightened environmental concerns in the 1970s and 1980s changed this "problem" of instability into an asset as the public became concerned about long-lived plastics filling up landfills. These concerns led Richard Wool, a UI material science professor, and other researchers to develop cornstarch-based plastics. Cornstarch-based plastics biodegrade more rapidly than common petroleum-based plastics — though recent reports indicate they may not degrade as rapidly as originally thought.

Plywood chips exhibiting wood failure (left) and glue failure (right).

The technology now exists to replace petroleum-based chemicals in plastics with starch-based chemicals from renewable resources such as corn and soybeans. However, manufacturers have lacked an economic incentive to adopt the technology. While starch-based chemicals are less expensive than petroleum-based chemicals, they are not compatible with monomers — simple molecules that combine to form polymers. To make the starch-based chemicals compatible with monomers, manufacturers usually must add other expensive chemicals into the mix, eliminating any possible cost savings and even making the starch-based plastics more expensive than the petroleum-based plastics.

The potential for making the process economically feasible, however, is certainly real. The polymer research group in the UI Department of Food Science has made that economic incentive the focus of its attempts to incorporate Illinois farm products into synthetic polymers. The research is centered on the belief that, while environmental benefits are a factor in the decision-making process of polymer manufacturers, economic benefits must provide the impetus for the change to corn- and soybean-based chemicals.

Saccharide Solutions

An example of this approach is the Food Science Department's ongoing research into monosaccharides and disaccharides that can be incorporated into polymers. The research is in conjunction with J.L. Willett, formerly of Fully Compounded Plastics of Decatur, Illinois, currently with the National Center for Agricultural Utilization Research in Peoria, Illinois. To address the problem of the lack of compatibility between starches and monomers, the researchers avoided direct incorporation of corn starches into thermoplastics. Instead, they converted corn-derived mono- and disaccharides, such as dextrose and maltose, into derivatives that can combine with petroleum-based chemicals. The combination of chemicals is more compatible with monomers than starch-based chemicals alone. Data obtained so far indicate that these polymerizable mono- and disaccharides may also allow larger amounts of extenders and fillers to be added to thermoplastics by making these low-cost, inert materials more compatible with common monomers. This could further lower the cost of saccharide-containing synthetic polymers without causing the loss of desirable properties. The process could even decrease the degradation time of the polymer — making it more environmentally attractive.

The technology now exists to replace petroleum-based chemicals in plastics with starch-based chemicals from renewable resources such as corn and soybeans.

A Multipurpose Molecule

Other research in this area includes the use of methyl glucoside, a corn-derived monosaccharide produced by the Grain Processing Corporation of Muscatine, Iowa. Methyl glucoside has been converted to various multifunctional monomers (MFMs). MFMs are molecules with more than one polymerizable group that can be used to cross-link and improve properties of polymers. The low-cost methyl-glucoside MFMs performed as well or better than commercially available MFMs that are derived from expensive petroleum-based alcohols.

A major portion of the Food Science Department's research with methyl glucoside is involved with its use in formaldehyde-based resins. This research initially concentrated on the potential economic benefits of replacing more costly materials with methyl glucoside, but an additional benefit was soon discovered — methyl glucoside can reduce levels of formaldehyde, a potential health hazard. Methyl glucoside can reduce

formaldehyde emissions from products such as clothing treated with formaldehyde-based "permanent press" finishing resins and from fiberglass insulation bound with phenol-formaldehyde resins.

Most of the research has centered on phenol-formaldehyde resins used as wood adhesives in products such as plywood. In the manufacture of plywood, there are two main points where renewable Illinois resources can be incorporated into the adhesive system: in the resin and in the glue mix.

In the manufacture of plywood, phenol-formaldehyde resins are synthesized in regional plants and shipped to numerous plywood mills. At the mills, the resin is combined with other chemicals and various extenders and fillers to make a glue mixture according to how that particular mill applies glue to veneer. The veneer used is either southern yellow pine, in the area from east Texas to the southern Atlantic coast, or Douglas fir, in the Northwest. The southern yellow pine plywood industry has been the focus of our research, simply because it is much closer to Illinois and its corn and soybeans.

Table 1.
Wood failure results from two southern plywood mills, with or without methyl glucoside in the glue mix, 6 to 12 months, 7 to 12 percent spread reduction

	Mill 1		Mill 2	
	Without	With	Without	With
Percent of panels with averages below 60 percent wood failure	4.1	4.0	3.2	2.9
Wood failure average (percent)	87.5	86.5	89.1	89.1
Total number of panels	1,880	1,855	715	658

NOTE: Wood failure is the measure of how well an adhesive works; it means that the adhesive is stronger than the wood itself. The American Plywood Association requires wood failure of greater than 80 percent for plywood to receive their stamp of approval.

Methyl glucoside was added to the glue mixes of various plywood mills with excellent results. Methyl glucoside was especially useful for reducing the amount of glue or spread required (see Table 1). It was also shown to reduce dry-out of the glue prior to the veneer being pressed into plywood. This is an important property for glue used in plywood mills during the summer when heat can quickly dry out the glue.

Despite these good results, many ply-

An Environment-Friendly De-icer from Corn

Chloride salts are used extensively today to melt snow and ice on highways and streets in the winter. Though effective under most circumstances, road salt has several drawbacks:

- It is extremely corrosive to metals, resulting in damage to cars, trucks, bridges, buildings, and numerous other structures that contact the salt.
- It can damage vegetation, such as grasses, which in turn can cause soil erosion when snow melts in hilly terrain.
- It can pollute waterways, rivers, lakes, and streams — some of which are main sources of drinking water.
- It can even damage concrete, which ruins roadways and concrete bridges.

The only saving grace for chloride salts would appear to be their low cost: $20 to $40 per ton. If the total effect of salt is taken into account, however, a much higher price is paid. The annual usage of chloride salts is 10 million to 12 million tons, and the resulting damage approaches about $14 billion to $20 billion per year. Thus, the true cost of road salt is $1,400 to $2,000 per ton.

What is the alternative to chloride salts? Numerous studies have shown that calcium-magnesium acetate (CMA) is a noncorrosive, nonpolluting, and environmentally safe de-icer. A derivative of the basic ingredient in vinegar, CMA has gained acceptance by the U.S. Federal Highway Administration and many state transportation departments as a possible replacement for road salt for roadway de-icing.

Only one company now produces CMA, and the company produces it using acetic acid purchased from petrochemical sources. The product's one drawback is a seemingly high price of $700 per ton (still cheap compared to the final cost of chloride salts).

CMA can also be produced from biomass by fermentation. Corn is the target of a current research program in the UI Agricultural Bioprocess Laboratory because a relatively sophisticated corn-refining industry already has the technical knowledge, experience, and financial strength to adopt CMA manufacturing technology.

If CMA use catches on and its production from corn becomes viable on a large scale, the potential benefits to U.S. agriculture could be immense. Conservative estimates indicate that if all the salt used today in the nation were replaced with CMA, it would create an additional demand for 220 million to 660 million bushels of corn and create a *new* $2 billion to $6 billion market. This would also translate into numerous new jobs in the manufacturing sector, not to mention the

wood mills have different glue mixes, making it difficult and time-consuming to optimize methyl glucoside in so many different systems. A better approach was to incorporate methyl glucoside into the phenol-formaldehyde resins that were being manufactured at regional plants. Research into this approach was initially supported by A.E. Staley Manufacturing Company of Decatur and more recently supported by the Illinois Corn Marketing Board and Grain Processing Corporation.

Phenol-formaldehyde resins for plywood normally use a formaldehyde:phenol (F:P) ratio of about 2:1, the optimum ratio for maintaining resin stability and cure rates. Higher F:P ratios are often desirable because they result in a lower-cost resin that cures faster. However, higher F:P ratios are usually not possible because of high levels of free formaldehyde left in the resins and formaldehyde emissions during curing, both significant health hazards. Superior research results were obtained when phenol-formaldehyde resins with F:P ratios as high as 4.2:1 were made by replacing half of the phenol in the resin with methyl glucoside. Free formaldehyde levels were reduced and cure times were shorter than normal. The shorter cure times are especially useful in the winters in unheated mills and are complimentary to the dry-out resistance obtained when methyl glucoside is added to glue mixes.

New Uses for Illinois Products

Unfortunately, the limited supply of methyl glucoside has somewhat restricted its commercialization. Therefore, the Food Science Department is continuing research into using more readily available corn-derived carbohydrates, such as dextrose, in plywood adhesives. Dextrose is available in much greater amounts and from more sources than methyl glucoside, but it can react with a catalyst in the phenol-formaldehyde resin, consuming it and forming undesirable products and slowing or stopping resin cure. This is the main problem that must be solved to pave the way for use of materials such as dextrose in phenol-formaldehyde resins.

UI food scientists are also initiating research into the possibilities of using soybean-derived materials, such as soy molasses and soybean meal, in plywood adhesives. This work, funded by the Illinois Soybean Producers Operating Board and the United Soybean Board, is still in its early stages.

Future research will also include structural panels other than plywood, especially oriented strandboard (OSB). OSB is mainly produced in the northern part of the Midwest — Minnesota, Wisconsin, and Michigan — making it convenient for Illinois products. OSB is an even more attractive target because more adhesive is required per panel than in plywood. Also, the phenol-formaldehyde resins used in OSB are not changed in the individual mills, meaning there are

added benefits to the environment and to our transportation infrastructure.

CMA has additional industrial uses that blend well with the growing demand for a cleaner environment. It could be used as an additive to coal-fired boilers and furnaces (such as those used by electrical utilities) to mitigate the problem of "acid rain." In addition to cleaning up the air, any such method to burn coal more cleanly could prevent the loss of several thousand jobs in Midwest coal mines and in coal-firing utilities.

CMA and other derivatives of acetate have recently been cleared by the Federal Aviation Administration for use as a de-icer at airports. Another intriguing use is as a medium for heat exchange (for example, to replace glycols used as antifreeze components).

A multitude of new environment-related applications are being investigated and can be expected to create a strong demand for acetates in the near future. The new applications will not only improve the environment but also create new demand for our agricultural commodities. — *Munir Cheryan, professor of food and biochemical engineering, Departments of Food Science and Agricultural Engineering*

If calcium-magnesium acetate catches on, road salt may become a thing of the past.

CornPak: Puffing Out the Landfill Problem

Plastic-foam packing materials are so widely used in such tremendous amounts that they have become a serious waste disposal problem. The expanded-polystyrene-foam packing peanut is often singled out as a particular nuisance: over 250 million cubic feet of these packing peanuts are used in the United States each year. Most don't get recycled, and many state and local governments now restrict the disposal of plastic-foam packaging materials in landfills. A new corn-foam loosefill packing material called CornPak, which was developed by the University of Illinois' departments of Agricultural Engineering and Food Science, may provide a solution to this problem. CornPak is a biodegradable, low-cost alternative to plastic-foam packing peanuts.

CornPak is made with an extrusion cooking process. Ground whole yellow dent corn, with a trace of soybean lecithin and a small amount of recycled newspaper (with soybean ink), is cooked in an extruder to over 300°F under high pressure. As the cooked corn mixture discharges from the openings, it puffs, and much of the moisture is lost as steam. Except for the slightly grayish color from the small amount of black soybean ink, the product resembles a corn- or cheese-puff snack food.

By changes in the extruder openings, the shape and size of the product can be varied. The target is a fairly uniform, somewhat peanut-shaped ball. CornPak is firmer to the touch than the usual expanded polystyrene foam packing peanut and more resistant to deformation, but it's also heavier. When weight is a big factor (such as in parcel post shipments), this might be an important consideration. However, a little extra weight would be negligible in terms of highway transport by semitrailers.

CornPak addresses the waste disposal dilemma at the most important point — source reduction. Like many waste components, recycling plastic foam involves costly collection, transportation, and processing. So, even though it can be recycled, it usually is not.

Disposal of used CornPak is easy. Since it is essentially cooked corn with a trace of lecithin and a small amount of cellulose, it can be placed out as feed for wildlife, composted, or simply tilled into your garden. CornPak disintegrates in water in about a minute.

Laboratory tests of CornPak demonstrated superior compressive strength as compared to commonly available loosefill packing materials. Drop tests evaluating its cushioning effectiveness showed characteristics as good as or better than comparable products on the market. User evaluations have been overwhelmingly positive, and responses from people receiving shipments in commercial trials of CornPak have been unanimously favorable.

CornPak is designed as a short-term-use product that is not only biodegradable but also made from an annually renewable raw material with minimum processing. Its distinctive appearance maintains its identity as an environmentally friendly product that should not go into the waste stream.

Compared to the highly centralized and capital intensive plastic-foam industry, CornPak technology requires a relatively modest investment, making it suitable for more widely distributed production locations. Widely distributed production may reduce transportation costs and create employment opportunities. Commercialization of CornPak technology is being undertaken by Innovative Packaging Corporation of Champaign, Illinois. — *Errol D. Rodda, professor of food and process engineering, Department of Agricultural Engineering, and Alvin I. Nelson, professor emeritus, Department of Food Science*

no glue mixes to worry about. This research, also in the early stages, is being done in conjunction with the University of Minnesota and its Natural Resources Research Institute.

Other new research into synthetic polymers includes attempts to incorporate soy molasses and soybean meal into polyurethane foams. Polyurethane foams are used as packing materials, insulation in coolers and refrigerators, padding for carpeting and upholstery, and in many other consumer goods. Once again, the economics of these systems need to be improved by replacing expensive polyalcohol components of the foams with renewable resources. An additional benefit of this research may be easier elimination of environmentally hazardous foaming agents such as Freon. This research is sponsored by the Illinois Soybean Producers Operating Board and the United Soybean Board.

These are just some of the challenging problems scientists are trying to overcome to increase the utilization of Illinois farm products in synthetic polymers. In the area of phenol-formaldehyde resins alone, a 50-percent incorporation of corn- and soybean-derived materials would mean a new market for over 500 million pounds of Illinois farm products. Researchers in the Food Science Department will continue toward their goal of increasing the amount of Illinois' renewable resources used in synthetic polymers.

Larson B. Dunn, Jr., assistant professor, Department of Food Science ■

Value-Added

Tailoring Crops to Fit New Markets

D.E. Alexander

The phrase *value added* has come to mean the result of change in a commodity through processing. An example: frozen chicken dinners ready for the microwave versus dressed chicken. The process of converting a raw commodity into a product of higher value adds to the economy by job creation.

A more subtle enhancement of value of a standard commodity may come by genetic change. Take cornstarch, for example. Ordinary cornstarch comes in two varieties: branched-chain starch (amylopectin) and straight-chain starch (amylose). During World War II, shipments of tapioca from the South Pacific were severely curtailed. Tapioca, a branched-chain starch, was an important if not essential commodity for many war-related efforts. To offset the scarcity of imported tapioca starch, a special type of cornstarch was used.

A corn mutant called "waxy" was already known to be composed of the same type of starch as imported tapioca. Fortunately, M.T. Jenkins of the U.S. Department of Agriculture had converted three standard inbreds to the waxy genotype, and in 1942, waxy hybrids came into commercial production. Waxy corns today are produced on a scale to meet industrial needs, and they command a premium price over standard corns.

Other examples of genetically altered corn include hybrids with high amounts of amylose, the "super sweet" sweet corns conditioned by the *shrunken-2* gene, and the high-lysine corn conditioned by the recessive gene *opaque-2*. The high-amylose types remain a specialty item used by wet millers to produce water-soluble transparent plastic. High-lysine corns remain a small part of the U.S. crop but are grown and fed on the farm by swine producers. The super-sweet types dominate the fresh on-the-cob market.

An important market is developing for high-oil corn. Current types contain 6.5 to 7 percent oil but also are 10 percent higher in protein. Further, the protein is of higher biological quality because of a greater proportion of the amino acids lysine and tryptophan.

High-oil hybrids are grown under contract. The corn is delivered to collecting elevators that maintain identity and ship to purchasers who pay a premium. Broiler producers, in particular, find these corns valuable in that substantial savings in feed costs are encountered. For each percentage point increase in oil (over standard corns), a savings of

Denton Alexander measures the oil content of a high-oil corn hybrid.

Smooth Move by Soy Researchers

Imagine eating a piece of chocolate that simply melts in your mouth. Fine chocolates have that particularly silky feel because they use cocoa butter, and fine chocolates are expensive because cocoa butter is expensive. Now imagine eating another high-quality chocolate, but one in which the melt-in-your-mouth sensation comes from a common (and less costly) Illinois product — soybeans. The possibility isn't as farfetched as you might think.

Soybeans are an excellent and inexpensive source of protein for use as human food or animal feed. They are also the world's largest source of dietary vegetable oil. However, soybean oil contains an appreciable amount of linolenic acid, a fatty acid that decreases the stability of the oil and limits its use.

If the fatty acid structure of soybean oil can be radically altered to produce more commercially useful products, a niche market will open. The Illinois farmer will be able to take advantage of this new market quickly because the operations and equipment necessary to produce such soybeans will be virtually the same as those used now.

Research in the Departments of Agronomy and Food Science has focused on improving soybean oil quality to make it more competitive in the world marketplace. In particular, the objective of the studies was to develop soybean seeds with unusual combinations of fatty acids that mimic desirable properties of foodstuffs such as cocoa butter or canola oil.

To achieve this goal, the fatty acid composition of soybean oil was changed genetically. First, the common Williams soybean variety was chemically mutated. After mutation, seeds were planted and harvested and the fatty acid composition determined. Seeds with altered oil compositions were in turn planted, harvested, analyzed, selected for desired composition, and crossed.

The modified soybean seed has produced several new combinations of fatty acids. These combinations may result in a more stable soybean oil for use in products such as shortening, cooking oil, and salad oil. Although a soybean oil that can substitute for cocoa butter in high-quality chocolate has not yet been produced, the combinations that have been achieved should be of interest to industry. — *Ted Hymowitz, professor of plant genetics, Department of Agronomy, and Ed Perkins, professor of food chemistry, Department of Food Science*

1.5 percent in feed cost is made. Thus, a hybrid with 6.5 percent oil will reduce the amount of corn needed in the diet by 3 to 3.5 percent. Similar advantages in savings have been observed in swine feeding trials. Although less convincing, high-oil corns may also have enhanced value in the management of high-producing dairy cows.

High-oil hybrid corn is a recent development. Earlier attempts, using a long-term high-oil selection of Burr's White, led to noncompetitive hybrids. More recent research, using wider-based genetic stocks developed at the University of Illinois, has led to acceptable hybrids ranging from 6.5 to 8.5 percent oil. These new hybrids are coming into commercial use and command premiums of 20 to 30 cents per bushel.

Genetic discoveries, followed by breeding procedures, have produced corns of enhanced value. These modified corns command premium prices relative to ordinary corn either because their identity is preserved through special handling or because they are more valued for their composition. Once the investment in research is made, the product remains more valuable without further attention. It can be expected that improved types, particularly those with better nutritional properties, will displace the older, traditional types bred without attention to such details.

Classical genetics and its big brother, plant breeding, have contributed mightily to improved grain quality. But the brave new world of molecular genetics promises even greater opportunities for plant breeding. The genetic material, DNA, can be transferred from one individual to another individual or can be transferred among or within species. Although transformation is in its infancy, great strides can be expected in a decade or two. The "how to" details are now being explored.

Perfecting the system of DNA transfer will lead to even more important questions. For example, "What are the characteristics we want in corn grain that do not now exist?" Without question, these approaches will lead to many special "enhanced value" types, the number being a consequence of what specialized types are needed for the market.

The following special types of corn grain are essentially producible today or in the next decade:

- corn with higher levels of certain vitamins, such as vitamin E
- corn with altered distributions of saturated and unsaturated fatty acids

Also predicted are corn varieties with the following attributes:

- specialized and unusual starch
- ability to produce enzymes foreign to the species (growth hormones, insulin, special enzymes used in fermentation processes, vaccines, and others)

Although the special qualities added through genetics and plant breeding may not be apparent to the naked eye, the added value becomes clear by the premium prices paid in the marketplace.

D.E. Alexander, professor emeritus, Department of Agronomy ■

Grain Lab Puts Money in Growers' Pockets

A producer growing a few acres of waxy corn must carry out separate planting and harvesting operations for those acres and might have to sacrifice outside rows to protect the waxy trait from contaminating pollen. Identity preservation of a value-added trait from planting to point of sale is an exacting way of farming. But the payoff from attention to detail — meticulous recordkeeping, field inspections, and seed testing — is premium prices, according to the Illinois Crop Improvement Association.

The ICIA, a non-profit organization started in 1922 as a seed certification agency, is a leader in grain quality testing. Jim Shearl, ICIA manager, reasoned in 1986 that special genetics coming out of biotechnology might offer farmers an opportunity to use "the better end of the crop." The high value placed on certain traits, such as protein or oil, could mean more money in growers' pockets. In an effort to pursue such opportunities for farmers, and with cooperation of the ICIA board and membership, Shearl started an Identity Preserved Grain Laboratory.

"Our premise from the beginning was that if the industry is going to merchandise value-added crops, there have to be parameters and benchmarks to answer: 'What is quality? What is high oil, hard endosperm, high starch?'" Shearl says. "We saw a need for quick, economical tests, and for a third party not associated with the commodities to do the testing."

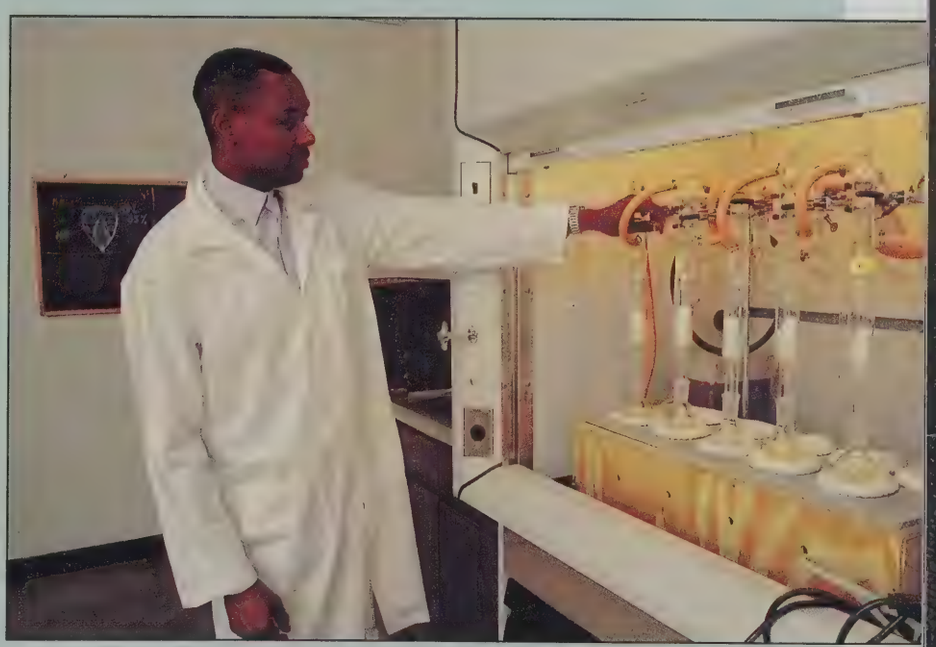
The ICIA's Identity Preserved Grain Laboratory was started in the Technology Commercialization Laboratory (TCL) on the University of Illinois campus, a low-cost location that allowed Shearl's team to focus resources on developing the idea of quality testing. They began with an extensive literature search to find established, reliable tests. TCL donated some used laboratory equipment, and a grant for technology transfer from the Illinois Department of Commerce and Community Affairs (DECCA) helped in setting up some key analytical instruments for the program. Subsequent DECCA grants were used to create awareness of the program and to work with the UI Agricultural Engineering Department on a device for predicting grain milling quality.

Today, the laboratory fills the back section of ICIA offices in Interstate Research Park, Champaign. Nearly 30 tests are offered, with fees ranging from $2 to $350 per test. The latest annual report, 1991, shows nearly 9,000 tests were performed for breeders, researchers, seed companies, exporters and importers, food- and feed-processing companies, grain houses, and farmers. Most customers wanted protein, oil, and starch tests, but some also asked for fiber, test weight, stress cracks, hardness, damage, and other analyses.

"The typical motivation for farmer testing is curiosity about the variety or quality of a commodity," Shearl says. "And many of our customers are plant breeders who need to establish a benchmark for something new they're working on."

As more value-added hybrids and varieties become available, the number of farmers growing specialty crops is expected to increase. Already, some Illinois farmers have used ICIA field inspection and testing services to fill contracts for premium-priced, value-added corn and soybeans. Their success proves that value-added traits can be protected and offer new opportunities for economic gains, Shearl says.

"We've focused on corn and soybeans, but there is potential to work with other crops as well," he says. "And we're continually looking for new, better, quicker, and cheaper tests — this is just the stone age of the identity-preserved crop era." — *Tina M. Prow, science writer, Agricultural Experiment Station*



Steve Mbuvi, a supervisor at the Identity Preserved Grain Lab, extracts oil from corn as a routine check of the instruments.

Value-Added

Renewed Interest in Renewable Fuels

Hans P. Blaschek and Bryan A. White

During the first half of the 20th century, alcohol fuels were produced from agricultural biomass. The acetone-butanol-ethanol (ABE) corn-based fermentation process using the microorganism *Clostridium acetobutylicum* was the principal way of producing acetone and butanol. But in the 1960s, these fermentation-derived fuels were effectively replaced by newly developed petrochemicals.

Today, consumers and government are demanding more efficient, cleaner burning, low-emission fuels, spurring a renewed interest in agriculture-based chemical fuels. Although petroleum prices are currently low, the nation must develop viable alternative fuels to offset both an uncertain supply of fossil fuels and a surplus of certain commodities.

During the 1980s, scientists developed microorganisms with improved fermentation characteristics. Progress continues on the genetic and physiological manipulation of *Clostridium acetobutylicum*, reinforcing the view that this microbial bioreactor system has ever-increasing industrial potential.

Benefits from Butanol

Butanol is an important industrial chemical. Ten billion pounds of butanol were produced worldwide by petrochemical processes in 1989. With butanol currently priced at $0.41 per pound, the current worldwide market is approximately $4.1 billion. This represents an increase of 21 percent over 1986 and a total increase of 3 percent during the past decade. If this amount of butanol were produced by fermentation of corn, it would translate into 136 million additional bushels of corn being utilized. This additional nonfood market for corn would have an obvious price-stabilizing effect on the commodity.

In addition to 7.7 pounds of butanol per bushel of corn, the ABE fermentation process produces 3.7 pounds of acetone and 1.9 pounds of ethanol. Recent modeling studies based on butanol at $0.30 per pound, corn at $3 per bushel, and propylene at $0.20 per pound suggest that butanol production from cornstarch can compete economically with current petrochemical processes. However, these studies were dependent on the use of a stable strain of *C. acetobutylicum* that produced high yields of butanol.

Butanol is used for the manufacture of plasticizers, resins, coatings, and brake fluids. It can also be used as an alternative to gasoline. It appears to be a better candidate as a "bio-fuel" than ethanol, the currently popular fuel additive. Compared to ethanol, butanol blends better with gasoline and diesel fuel, has lower vapor pressure, and mixes less easily with water. All of which makes it a superior fuel extender.

Ethanol is limited as a fuel in internal-combustion engines because it requires engine design modifications. The butanol-acetone-ethanol fermentation mix (produced in a ratio of 6:3:1) is referred to as *baelene*. Baelene has been successfully used in diesel engines as well as in unmodified automobile engines. Because carbon dioxide and water are the end products of combustion, butanol creates less pollution than petrochemical-based fuels.

Butanol has other uses besides as a fuel. For example, it can be used as a food-grade extractant in the food and flavor industries. Use of petroleum-derived butanol is not desirable in the food industry because of the potential for carcinogen carryover. It is expected that this new market could support a higher-than-normal price and be independent of market conditions for petroleum-derived butanol.

Putting Waste to Work

In addition to cornstarch, agricultural wastes and food-processing byproducts have the potential for use as inexpensive substrates (substances acted upon) for the ABE fermentation process. Examples include cheese whey (a major waste byproduct in the dairy industry), mycotoxin-contaminated corn, and various types of cellulosic materials, including corn cobs and stalks. There has been considerable research effort aimed at the fermentative production of butanol from cheese whey, as well as at the use of cellulose and wood hydrolysates as fermentation substrates. The ability of *C. acetobutylicum* to produce cellulase enzymes and to utilize the cellulose breakdown products bodes well for the fermentation production of butanol from this carbohydrate. To make ABE fermentation economically viable, however, a number of problems must first be addressed.

Development of Genetically Engineered Microbes

The high recovery costs due to the rather low final concentration of butanol in the fermentation broth is an important limiting factor in the production of butanol. *C. acetobutylicum* is intolerant to even low concentrations of butanol. When the percentage of butanol reaches as little as 1.3 percent of the fermentation broth, growth of *C. acetobutylicum* and, hence, fermentation are inhibited. If the percentage of butanol could reach 2 percent, this would lower the energy requirements for distillative recovery of the butanol by a dramatic 62 percent. Such an increase in butanol concentration would help to make this fermentation economically viable.

One approach toward understanding the mechanism of butanol tolerance is to produce mutants and study their specific characteristics. In the early 1980s, UI food scientist Hans Blaschek developed a strain of *C. acetobutylicum* (SA-2) that was more than twice as tolerant to butanol than the parent. An examination of the SA-2 strain indicated that it was better able to alter the fluidity of its membrane. By synthesizing increased amounts of saturated fatty acids, this strain developed a mechanism to compensate for the membrane-fluidizing effect of butanol and thereby maintain a more stable membrane.

An additional rate-limiting step in the fermentative production of butanol is the efficient utilization of the complex carbohydrates, starch and cellulose. Although *C. acetobutylicum* is able to utilize components making up starch and cellulose, it must first break down these complex molecules into smaller molecular units to allow for transport across the cell membrane. This is typically achieved by the microorganism secreting starch- or cellulose-degrading enzymes. *C. acetobutylicum* is able to do this, albeit inefficiently. As a consequence, the fermentation may be delayed or not proceed at all. The genetic amplification of these enzymes is seen as a way to improve the substrate-to-product conversion efficiency, decrease the overall fermentation time, as well as allow for simultaneous breakdown and fermentation of starch- or cellulose-based biomass.

UI food scientist Hans Blaschek (below) uses lab techniques to develop improved strains of C. acetobutylicum *(left), the microorganism that turns biomass into butanol.*

A superstarch-degrading strain of *C. acetobutylicum* (designated BA101) was developed using classical genetic techniques. Enzyme production by the BA101 strain was nearly twofold higher than that of the parent strain and it produced 50 percent greater amounts of butanol. This increase in butanol production is expected to be further enhanced by the incorporation of the genes encoding enhanced starch breakdown activity from BA101 into the butanol-tolerant *C. acetobutylicum* SA-2 strain discussed above.

A supercellulose-degrading strain of *C. acetobutylicum* (designated BKW-1) was recently developed using genetic engineering. The cellulose-degrading gene was cloned from another non–butanol-producing *Clostridium (C. cellulovorans)* and subsequently introduced into *C. acetobutylicum* using gene-transfer techniques and protocols developed during the past decade. Whether this strain is able to utilize cellulose as the sole carbon source is currently under investigation.

Future Prospects and Commercialization

In order to determine the usefulness of the newly developed *C. acetobutylicum* strains, these microbes need to undergo additional testing in large-scale fermentors. If these *C. acetobutylicum* strains behave as predicted, producing increased amounts of butanol using either starch- or cellulose-based biomass, their use under "real world" conditions will be bright indeed. Plans for field trials and commercialization of the developed strains are currently under way in cooperation with various companies.

Hans P. Blaschek, Department of Food Science, and Bryan A. White, Department of Animal Sciences ■

Back to the Future: A New Look at an Old Process

More than a century ago, Louis Pasteur observed that bacteria produce butanol, today's "feedstock chemical" used for manufacture of plasticizers, resins, coatings, brake fluids, and alternative fuels. The finding, reported in 1861, became compelling when a shortage of natural rubber developed in the early 1900s. Strange and Graham Ltd., England, used microbial fermentation of potatoes in the first attempt at commercial production of acetone and butanol for synthetic rubber in 1913.

But a year earlier, Chaim Weizmann, a chemist who had worked with Strange and Graham Ltd. for a decade before pursuing independent research, had found what would become the most widely used organism and process for fermenting starchy grains to acetone, butanol, and ethanol (ABE). Weizmann obtained a patent for his ABE fermentation process in 1915. Already a year into World War I, the English government backed Weizmann to manufacture acetone for cordite (smokeless powder) explosives. A shortage of grain the following year prompted the government to move operations to Canada, where 3,000 tons of acetone and 6,000 tons of butanol were produced before armistice.

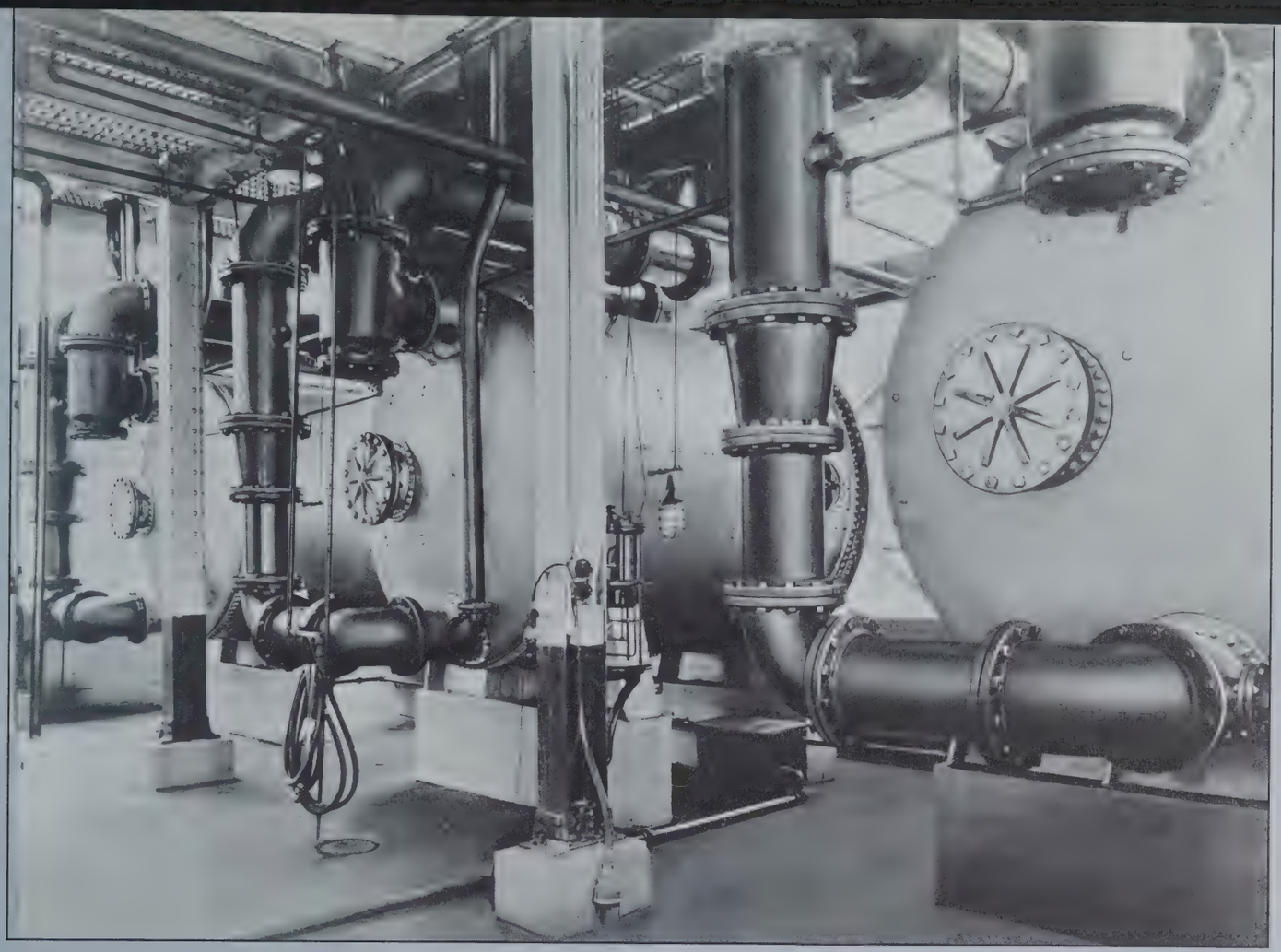
During the war, the English also cooperated with the U.S. government to convert a Corn Belt distillery to ABE fermentation. Between May and November 1918, a Terre Haute, Indiana, plant manufactured acetone both for cordite and for chemical protectant for airplane wings. With peace, acetone production in Canada and the United States ceased; it was no longer needed.

But the butanol that had accumulated as a byproduct of acetone production during the war was needed and provided the next impetus to the ABE fermentation industry. E.I. du Pont de Nemours & Company spearheaded use of butanol as a solvent for quick-drying lacquers used in the burgeoning automobile industry.

In addition, farsighted U.S. entrepreneurs formed the Commercial Solvents Corporation of Maryland and bought the Terre Haute plant. By 1920, they were operating the first U.S. commercial ABE fermentation plant. They eventually acquired worldwide patent rights to Weizmann's and similar processes.

Photos courtesy of W. Gene Vaughn, Vigo Preservation Alliance

Wagons filled with corn deliver their loads to the Commercial Solvents Corporation fermentation plant in Terre Haute, Indiana, in 1923.



In 1922, Commercial Solvents Corporation built its largest facility to date in Peoria, Illinois. Pictured are solvent recovery kettles.

By 1923, the demand for butanol supported 52 fermentors in the Terre Haute plant. But that year, a virus infected the butanol-producing bacteria, which cut fermentation production by half. The entrepreneurs responded by investing in a research program at the plant, providing research grants to the University of Wisconsin, and converting a distillery in Peoria, Illinois. Committed to the venture, they also would successfully defend their patent rights in English and U.S. courts over the next decade.

The demand for butanol drove expansion. By 1927, the two plants were producing 100 tons of solvents per day, with more than half going to lacquer production. Researchers focused on uses for byproducts, such as gasses for producing ammonia, and on isolating new bacteria for fermenting higher starch concentrations.

A molasses glut also prompted scientists to seek organisms that could ferment sugars. Success made ABE fermentation even more economically attractive. At least 18 patents were issued for new fermentation strains, usually for molasses. Plans for a pilot plant, rejected in the 1920s, were revived in England. In 1936, the Weizmann patent expired and ABE plants opened in Philadelphia, Baltimore, and Puerto Rico. Within a few years, ABE plants could be found in Japan, India, Australia, South Africa, Taiwan, Egypt, and Brazil.

World events spurred ABE expansion even further when acetone for manufacture of munitions became a priority during World War II. Demand led to development of multiple-column continuous distillation units to increase fermentation capacity.

With the end of the war came a decline in ABE fermentation. Cheap petroleum-based feedstocks made the synthetic chemical process more economical. At the same time, farmers began using molasses for cattle feed, driving the price up. By the early 1960s, ABE fermentation ceased in the United States. Today, commercial ABE fermentation is found only in China, where sweet potatoes are used to make butanol.

Even so, scientists continue to study ABE fermentation. Since the 1980s, genetic researchers have had some success developing strains with improved fermentation characteristics. There is some optimism that demand from the food additive and flavor industry may revive commercial ABE production. Historically driven by world events, ABE fermentation is ever poised for a comeback — when an oil embargo lasts too long, concern for the finite fossil fuel resources becomes too great, or petrochemical costs rise too high. —
Tina M. Prow, science writer, Agricultural Experiment Station

Value-Added

Less Is More with Low-Fat Meat

Tina M. Prow

How should I cook this?

Jim Hankes hears that question often since Thrushwood Farms Quality Meats, Inc., began offering lean meat cuts and trimming fat as closely as possible. Providing custom service, the Galesburg meat processor keeps up with trends and changes in taste and preferences. His customers want lean meat, he says, and they want it to taste good.

"It's a little like wanting the cake and the frosting, too," Hankes says. "They want lean, but miss the flavor that fat gives to meat. But if they're willing to rethink the way they cook — to cook slower, add moisture, and use a lower temperature — they can have the health and nutritional benefits of lean meat and have a good-tasting meat."

Keeping consumers happy with lean meat requires a commitment to education, he says. "Older cookbooks are out of date. The instructions and methods people used when meat had more fat just don't give satisfactory results with leaner cuts. Plus, home ec isn't offered in most schools anymore, so a lot of people don't know much about cooking. Every day, I advise customers and answer questions on how to cook lean meat."

The leaner the meat, the more costly it is to produce, making for a more expensive product at the checkout counter. Increasingly diet-conscious consumers seem willing to pay more for less fat, however, and the industry is accommodating that demand.

Today, consumers can find a variety of lean meat products in the meat cases of most local grocery stores. Some hams are 95 to 98 percent fat-free. Some closely trimmed, fresh beef and pork cuts may have less than 5 percent fat. Chicken and turkey franks, sausages, and luncheon meats are low-fat alternatives to traditional processed beef and pork products. Even beef and pork hot dogs and sausages, which once weighed in at 30 percent or higher fat content, are going lean.

Research under way at the University of Illinois is likely to expand the lean-meat product selection even further.

Bovine Somatotropin and Milk Production

Technological advancements in the production of milk by dairy cows has enabled the dairy farmer to supply the consumer with high-quality milk at a lower cost. Bovine somatotropin is one advancement that offers potentially improved milk production.

Bovine somatotropin (bST) is a protein made up of 191 amino acids. The protein is produced by the pituitary gland and regulates the supply of nutrients flowing to the mammary gland for synthesizing milk.

Research on the effects of bST is not new. The first research, conducted in the 1930s, indicated that bST increased animal growth and milk production. However, bST supplies were not adequate for commercial use until the 1980s, when new recombinant DNA technologies made it possible to efficiently produce an abundant supply of bST.

Bovine somatotropin is produced by isolating the gene responsible for bST production in the pituitary gland of dairy cows and transferring that gene to bacteria. The bacteria produce bST through standard fermentation techniques. Bacteria are then killed, and the bST is separated and highly purified before injection into dairy cows.

Research with an estimated 30,000 to 40,000 dairy cows indicates that bST increases milk production by 10 to 15 percent and improves efficiency of feed use by 5 to 15 percent. To be effective, bST must be administered by injection. The injection usually begins during the second or third month of lactation and continues to the end of the lactation period. Administration of bST can be in daily injections or in sustained-release formulations.

The greatest response to bST is obtained in herds that are well managed. Poor management of bST-injected cows may result in no improvement in milk produc-

tion and may even decrease milk production. Nutrient composition of the diet does not have to change, but cows normally eat more feed and use it more efficiently as milk production is increased.

Bovine somatotropin used at anticipated commercial dosage in well-managed herds has shown no undesirable effects on the cows or their calves. Additional benefits are that bST will not require a large capital investment for facilities or equipment, and it will be equally effective for both small and large dairy farmers.

Milk produced by cows treated with bST is safe to drink and does not cause health hazards for several reasons:

- bST is a natural component in cow milk, and its presence in milk is not significantly increased after injection.
- bST is inactivated at pasteurization temperatures of 70 to 80°C.
- When given orally, bST is not absorbed in a biologically active form in either cows or humans. Because bST is a protein, it is broken into small peptides and amino acids by proteolytic enzymes in the digestive tract of humans and is destroyed in the digestive tract before absorption into the body.
- bST is inactive in humans even when it is injected because the amino acid composition of bST and human somatotropin is different.
- The nutrient composition of milk from bST-treated cows is not significantly different from milk produced by nontreated cows.

Bovine somatotropin is under review by the FDA for marketing by at least four pharmaceutical companies. The FDA stated that the milk and meat are safe for human consumption but has not announced a date on which it will complete the evaluation of data supplied by the pharmaceutical companies. When approved for commercial use in the United States, the principal effect of bST on the dairy industry will be to allow dairy farmers to compete more effectively in global markets — fourteen countries have already completed their reviews and approved bST for commercial use. — *Jimmy H. Clark, professor of nutrition, Department of Animal Sciences*

Partially funded by such groups as the National Live Stock and Meat Board, Illinois Beef Council, Illinois Pork Producers Council, National Pork Producers Council, Monsanto, Cyanamid, and Eli Lilly, UI researchers helped to develop a new, lean ground beef and are working to get the fat out of other processed meats.

"In the past decade, public concern about dietary fat and the contribution of saturated fats from meat, particularly processed meat, to health problems has increased," says Floyd McKeith, a UI meat scientist. "There is a great deal of interest from the livestock and meat industry in enhancing the value and perception of these products by altering their composition."

McKeith and fellow meat scientists, including graduate students, keep consumer attitudes uppermost in mind as they work in the UI Meat Science Laboratory. It is easy enough to remove fat — the researchers have made frankfurters with 5 percent fat. But the frankfurters were tough and rubbery and unlikely to go over at any ballpark, McKeith says.

"Fat can make a product unacceptable from a dietary standpoint, but lack of fat can make it unacceptable from a taste standpoint," McKeith says. "So we have to find something that can do the job of fat without presenting a health concern."

The meats team is exploring non-meat ingredients as healthful alternatives that may "do the job of fat" — provide juiciness and tenderness. Food starches, carbohydrates from seaweed, soy protein, oat flour, and oat bran are a few of the non-meat ingredients added to experimental recipes for processed meats in the UI laboratory. These ingredients limit the binding of protein, which makes processed meats tough when fat is reduced. But the ingredients are effective at binding water, which contributes to tenderness and juiciness of processed meats. Creating a good-tasting, low-fat processed meat product, then, is a matter of determining how much fat can be cut, identifying the best additive ingredient, and determining the optimum amount to add to processed meat. (All additives must be approved by the Food and Drug Administration before being used in any marketed product.)

In addition to non-meat ingredients, researchers are studying processing practices that affect ground beef and pork products. Juiciness, tenderness, and other texture characteristics of a product can be altered by adjusting particle size during grinding, pressure used to form the product, mixing time, or temperature.

The debut of a lean hamburger at a major fast-food chain last year was a milestone in consumer acceptance of additives to make meat products healthier, McKeith notes. An additive made from seaweed carbohydrate helped make the lean-meat hamburger more palatable. UI researchers participated in the effort to determine the acceptable level of the additive and the best manufacturing practices. The low-fat ground beef is expected to be on school cafeteria menus soon.

"If consumers really want low-fat meat products, they have to accept non-meat ingredients," McKeith says. "We can reduce fat to about 15 percent in ground beef and still have an acceptable product, but reducing fat more than that gives us something that most consumers wouldn't want.

"And consumer attitude is everything," McKeith continues. "If you develop a product that has great health attributes, but is unappealing in taste, or look, or smell, the product just won't work."

Reducing Fat on the Hoof

Surveys by many industry and independent groups link consumer concern

about saturated fat and calories to a drop in red meat consumption in the 1980s, according to Tom Carr, a UI meat scientist working with McKeith. Funding of UI research to develop low-fat and fat-altered meat products is a long-term strategy the industry is employing to win consumers back. In the short-term, the industry is looking to producers to come up with leaner animals.

"The meatpacking industry is demanding a carcass with less fat, so there is tremendous pressure on livestock producers to provide less fat and more muscle," he says. Today, producers are using research-based feed formulations designed to assist in the reduction of fat.

In the future, producers may raise animals genetically predisposed to have less fat. Producers also may feed animals special diets, such as the soybean-based diet being tested by Robert Easter at a UI facility. He is feeding processed soybeans to swine to find out if a diet high in unsaturated fat will reduce the saturated fat of meat and meat products. If successful, a bonus for Illinois agriculture is that this diet would provide a new use for an Illinois-grown crop. The data look positive, according to the animal scientist, but there is a drawback: Bacon from animals on the soybean diets becomes soft and oily. Because consumers might be put off by that, improving bacon quality is now part of the research problem.

The efforts of researchers, producers, and the meat industry to give consumers what they want will keep meat on the table, Carr predicts.

"Overall meat consumption did not decrease in the 1980s," he notes. "Consumers simply replaced some lamb, beef, and pork in their diets with poultry, turkey, and fish."

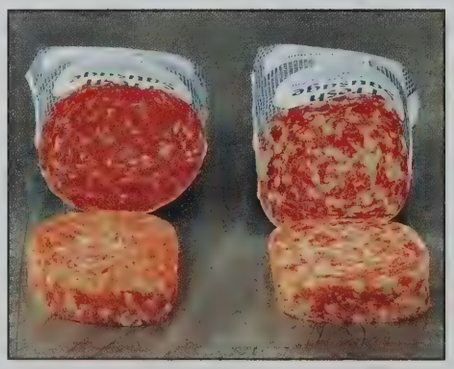
Furthermore, the decline in red meat consumption appears to be leveling off. He attributes that to the increasing array of lean meat products consumers can choose from now and the increase in advertising aimed at bringing consumers back to beef and pork.

"Perceptions about meat have been an integral part of the market shifts," Carr says. "Education on what they're buying and how to cook it will be key to helping consumers understand how low-fat and new, fat-altered meat products can fit into their diets."

Labels Will Tell

Consumers will have a better idea of what to expect when they pick up a package of meat as the industry responds to new labeling legislation requiring more information on products by 1994. Fresh or processed meat products with the description "lean" and "lite" on the labels will be evaluated by FDA to ensure that the products meet guidelines set for those terms. Meat product labels will contain expanded nutritional information. If food additives are part of the product, they will be listed among the ingredients.

Rebecca Bull, graduate student in Animal Science, demonstrates three ways to trim fat from meat.



The pork sausage on the left uses carrageenan to bind moisture and has less than 10 percent fat. The sausage on the right does not use non-meat ingredients and is approximately 30 percent fat.

Consumers may be surprised at what they learn from labels, according to Jan Novakofski, a UI meat scientist working with McKeith and Carr.

"Because of misconceptions, marketing, and misinformation, fresh meat products often are incorrectly viewed as much 'fatter' than they are," he says. "Consumers see fat on fresh pork or on a steak and assume they're fatty products. But if the consumers trim that fat and broil the meat, it's probably about 4 percent fat and 20 percent protein."

The saturated fat in meat is a red flag to many consumers concerned about cholesterol. But the total amount of fat — rather than the source of fat — is what presents a health risk to certain people, Novakofski notes. He explains that the function of cholesterol in the blood is to transport fat. So a cholesterol-free diet that remains high in fat still presents a health risk because the body will make enough cholesterol to move the fat.

"The key to controlling cholesterol is controlling total fat, no matter what the source. But confronted with a peanut butter sandwich at 25 percent fat and no cholesterol, and a fat-trimmed pork chop or steak at 2 to 5 percent fat and some cholesterol, many health-conscious people might choose the 25 percent fat, no-cholesterol peanut butter because there has been so much emphasis on 'no cholesterol.'

"Consumers who are trying to make smart choices about meat in their diets will have to take more than numbers and marketing into consideration," Novakofski says. "Labeling is a very positive thing for the meat industry and for consumers, but there is a massive educational process ahead."

Tina M. Prow, science writer, Agricultural Experiment Station ■

Value-Added

Microencapsulation Adds Value to Illinois Crops

Ion C. Baianu, Richard L. Magin, and Eiichi Ozu

Researchers at the University of Illinois are developing new and innovative technologies for microencapsulation in foods and pharmaceuticals, offering manufacturers exceptional flexibility in a wide range of applications. Employing corn and soy proteins, the new technologies also have the potential to expand the markets for cereal grains and soybeans.

One significant benefit of microencapsulation is its usefulness as a preservation method. Stored in "watertight compartments" made of soy lecithin, substances such as flavors, vitamins, and medicines can be protected from oxidation or degradation. For instance, flavors can be isolated from other ingredients until cooking; alternatively, medications can be contained until they are delivered at selected locations inside the body.

Products made from corn and soy protein are creating commercial interest partly because they are biodegradable — unlike traditional petroleum-based products — and also because they can be sterilized for pharmaceutical uses. Biodegradable, recyclable, sterile, plant-derived materials have the potential to replace polyethylene films and solids in some industrial applications. In addition, a corn-protein fat replacer made by using microfluidization technology is being utilized in a variety of foods, such as dairy products (yogurt, soft cheeses, creamers) and sausages.

Historically, food processing evolved from simple methods that were first tried in the home. The requirements of mass production and lower costs, however, have transformed food processing into a sequence of well-defined engineering steps that employ sophisticated machines specifically designed for food engineering. A classic example is the food extruder, now used by the food industry for making a variety of products, including pasta, cheeses, and breakfast cereals.

Higher consumer and nutritional standards are making increasing demands on both the formulation and processing abilities of food engineers. As a result, consumers are seeing a growing number of food products with higher nutritional content, lower cholesterol, and increased shelf life.

What Is Microencapsulation?

Microencapsulation is a refinement of an existing technique for processing foods known as encapsulation. Encapsulation refers to a group of methods used to achieve increased flexibility in the formulation of foods and improved food product stability. Its origin stems perhaps from the old method of storing olives or sardines in oil. The basic idea is to surround the food component (such as vitamins) needing protection with a thin capsule of either polysaccharide or lipid material to prevent or diminish the deterioration of the encapsulated food ingre-

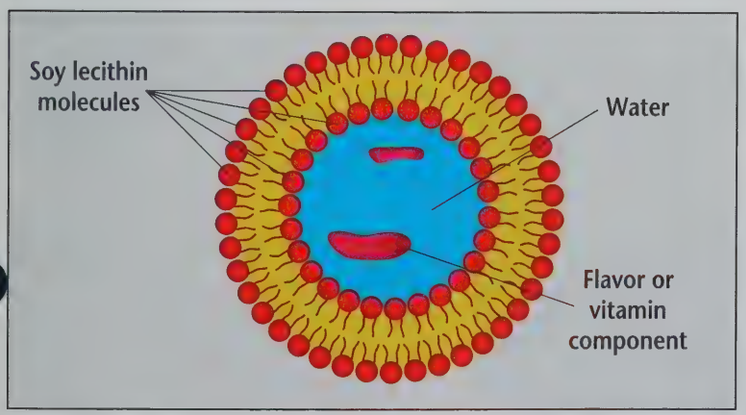


Figure 1A. Simplified representation of the molecular organization of a microcapsule, showing a bimolecular leaflet of soy lecithin that entraps flavors and/or vitamins dissolved in water in the interior of the microcapsule.

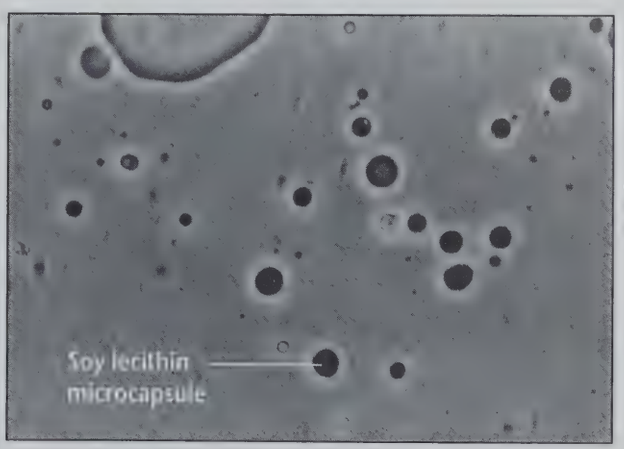


PHOTO COURTESY OF ION BAIANU

Figure 1B. Actual photo of soy microcapsules. Each microcapsule is about 1 micron (one-millionth of a meter) in diameter.

dient during or after processing. The use of such procedures is primarily skill- and cost-driven.

A new approach to encapsulation, called microencapsulation, was recently introduced by limiting the encapsulation material to a film of one- to two-molecule layers (for example, made of phospholipids), and by producing microcapsules through an extrusion-like process that uses high-pressure mixing of lipids and water solutions containing the ingredient that will be encapsulated.

The Research Project

UI food scientists working with the new technologies have focused on four groups of food ingredients for microencapsulation within lipid vesicles (Figure 1): soybean proteins, corn proteins, vitamins, and volatile flavors (which readily pass off by evaporation). The aim is to create a cost-effective methodology that can be used by the food industry.

The researchers' project has four major objectives:

- to develop microencapsulation technologies suitable for a wide range of food applications
- to formulate four new food products improved by microencapsulation
- to assemble a processing machine to readily make microcapsules for food applications (see illustration of a "microfluidizer," Figure 2)
- to explore the use of microencapsulation in selected pharmaceutical and medical applications (for example, the safe delivery of toxic drugs currently employed in cancer chemotherapy)

What the Research Shows

Soy lecithin microcapsules, such as those shown in Figure 1, have been made for various food applications. The following food ingredients have been microencapsulated in UI laboratories:

- **Enzymes**. Accelerated ripening of cheese is obtained with certain enzymes that are microencapsulated, then mixed evenly in the cheese and released during processing.
- **Food proteins**. Soybean and cereal proteins were encapsulated for the purpose of using these large molecules as flavor and vitamin carriers. During storage of foods, flavors may be lost, especially the volatile compounds. Microencapsulation allows the retention of flavors during food storage. Brief heating releases the flavors into the food just before serving. Vitamins that are normally stored in hard, large-size capsules, such as in the case of vitamins A and E, are also readily preserved by microencapsulation.

Other applications of microencapsulation to food processing are currently being tested to engineer new foods with formulations that provide improved flavors, stability during storage, and high nutritional quality.

Quality control of the microcapsules for their stability and encapsulation abilities is carried out by employing state-of-the-art instruments such as nuclear magnetic resonance and electron paramagnetic resonance spectrometers; spectrofluorometers; and laser light-scattering instruments.

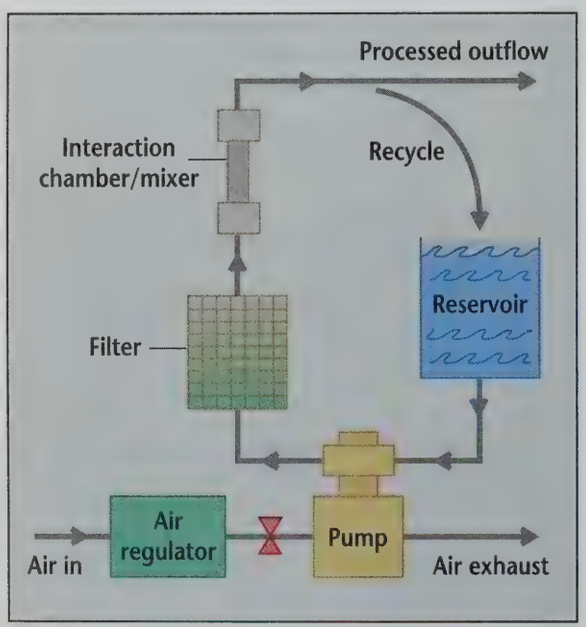


Figure 2. How a microfluidizer works. A microfluidizer is a machine to make microcapsules for food applications.

Edible Films

Partial replacement of plastic film packaging of foods by edible films has several attractive features. The absence of a residual material eliminates the need for disposal, and the edible film itself is made of renewable materials such as food proteins and starch.

UI scientists have made several new edible films for food and pharmaceutical packaging applications that contain a mixture of corn and soy proteins, or corn protein and starch. The starch granules embedded in the corn protein film provide improved rehydration and cooking characteristics. Such films were tested, for example, on cooked beefsteaks. Another application of such films, under development, is the replacement of gelatin capsules for medicines.

The results presented here are only a few examples of the new possibilities in food engineering for using microencapsulation and cereal (edible) films. These new products are creating commercial interest and are likely to increase significantly the combined utilization of cereal and soy proteins in foods.

Further information on microencapsulation can be found in the following publications:

- Baianu, I.C., ed. 1992. *Physical Chemistry of Foods*. See chapters 1, 4, 5, 8, and 9. New York: Van Nostrand Reinhold.
- Kim, H-H., and I.C. Baianu. 1991. Novel liposome microencapsulation techniques for food applications. *Trends in Food Science and Technology* 2(3):55–61 (and references cited therein).
- Baianu, I.C. 1989. High-resolution NMR studies of food proteins. Chapter 6 in *Nuclear Magnetic Resonance in Agriculture*. Pfeffer, P.E., and W. Gerasimowicz, eds. Boca Raton: CRC Press.

Ion C. Baianu, associate professor of food chemistry, Department of Food Science; Richard L. Magin, professor of electrical and computer engineering, College of Engineering; and Eiichi Ozu, postdoctoral research associate, Department of Food Science ■

Value-Added

New Weapon in the War Against Chronic Disease

Clare M. Hasler

The medical and scientific research communities have long known that the lack of certain essential dietary nutrients can lead to deficiency diseases (examples include the lack of vitamins C and D and the development of scurvy and rickets, respectively). However, research conducted over the past decade has revealed that many previously ignored dietary components may actually promote health and prevent chronic disease. Isolated natural compounds, diet supplements, and genetically engineered designer foods are all nutrition products with disease-related benefits that are under review by mainstream medicine and have become a focus of consumer interest.

A driving force behind the increased interest in diet and chronic disease prevention is the reality of a rapidly aging population in the United States. People are living longer, and they want to remain healthy and active in their later years — a time when chronic diseases primarily manifest themselves. Dietary intervention designed to prevent or postpone chronic disease can not only increase the quality of life, but also dramatically decrease the cost of health care for all of us.

You Are What You Eat

Through the study of dietary habits of different populations around the world, scientists found that those groups consuming a plant-based diet rich in vegetables, fruits, grains, and legumes (diets consequently high in fiber and low in fat) had a lower incidence of chronic disease, particularly cancer and heart disease. This observation prompted an intense search by researchers to identify the specific foods or food components responsible for disease prevention. They discovered that certain minor dietary constituents, now collectively referred to as phytochemicals, may be at least partially responsible.

Phytochemicals are plant chemicals — naturally occurring, non-nutritive substances present in small amounts in such common foodstuffs as cruciferous vegetables (cabbage, broccoli, cauliflower, and brussels sprouts); citrus fruits (oranges, lemons, grapefruits, and strawberries); grains (oats, flax, brown rice, and whole wheat); certain spices (for example, rosemary); green tea; garlic; licorice; and soybeans. Phytochemicals have biological activity that not only enhances plant survival but has medicinal value for humans consuming plants. Scientists are working to locate additional plant substances that contain phytochemicals, and they are beginning to discover just how these dietary substances disrupt the molecular pathways that can lead to disease.

Phytochemicals are naturally present in foods such as broccoli, cauliflower, and oranges.

Coloring Food Naturally

Plant cells from familiar horticultural and agronomic crops are an underestimated resource for many valuable secondary products, including rich natural pigment extracts and compounds with medicinal value. As consumers have become more aware of (and resistant to) artificial food additives and synthetic chemicals, research has shifted to explore these safe, practical alternatives derived directly from plants.

Synthetic color additives routinely replace colors destroyed during food processing. However, synthetic colorants have been implicated in adverse health effects, including hyperactivity in children, various forms of cancer, allergies, and brain dysfunction. Consumer opposition to artificial additives and changes in legislation, including tightening governmental restrictions or bans on many synthetics, have created market demand for foods formulated with natural ingredients.

Harvest and extraction of plant pigments directly from field crops is restricted by several problems. However, plant cells *in vitro* can be stimulated to produce and accumulate pigments, and the producer of *in vitro* cells has much greater control over purity and product uniformity. Therefore, the bright colors produced in, for example, cranberries and grapes can be synthesized by intensively cultivated cells from these plants. Once research identifies the exacting conditions required to stimulate pigment production, the cultured cells can be produced on a larger scale, which will have the effect of in-

a b c

Figure 1. Obtaining pigments from plants involves several stages. In this case, the bugleweed is the source (a). The plant is grown in a sterile environment (b), then callus cells are produced from a bugleweed leaf and grown on a semi-solid medium (c). That culture is placed in a liquid medium, shaken, and continues to grow (d). Color is then extracted from the in vitro *cells (e). The final picture shows a food product colored artificially that could use natural pigments instead (f).*

Functional Foods for Health

University of Illinois faculty from Urbana-Champaign (UIUC) and the Chicago campus medical center (UIC) have joined to develop a unique, multidisciplinary research effort to study relationships between food components, health outcomes, and risks for development of diet-related diseases. Phytochemicals are a primary focus of research conducted by faculty associated with the Functional Foods for Health (FFH) program. Researchers involved in the program include director Clare M. Hasler, Department of Food Science at UIUC and the Departments of Nutrition and Medical Dietetics and Medicinal Chemistry and Pharmacognosy at UIC; and codirectors Phyllis Bowen, Nutrition and Medical Dietetics at UIC, and John Erdman, Division of Nutritional Sciences at UIUC. Richard L. Huston, in the office of the Vice-Chancellor for research at UIC, acts as a liaison to industry groups, facilitating an Industrial Affiliates program.

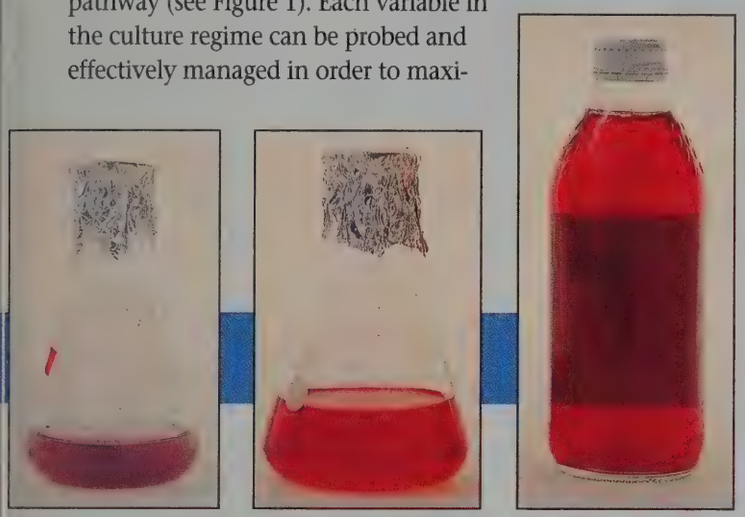
In a little over two years, the FFH program has evolved into an active, intercampus research program composed of approximately 50 faculty. The FFH program fosters the long-term collaboration of interdisciplinary research teams and attempts to determine specific roles of dietary phytochemicals in health and disease. Another important objective of the FFH program is the education and training of undergraduate and graduate students and post-doctoral fellows in modern laboratory techniques used in phytochemical research.

Soy is one example of foodstuffs studied in detail by several people in the FFH program. These researchers have identified a number of phytochemicals in soy that are thought to decrease risk for cancer and heart disease. Evidence of the health benefits of soy were demonstrated in two recently completed studies conducted at the Veterans Administration Hospital in Danville in east-central Illinois under the direction of Susan M. Potter, Division of Foods and Nutrition at UIUC.

Results from the first study showed that consuming 50 grams (about 1 cup) of isolated soy protein incorporated into bakery products and added to a traditional low-fat/low-cholesterol diet resulted in a 12 percent reduction in total cholesterol and an 11.5 percent reduction in LDL-cholesterol in men with initially high blood cholesterol concentrations. One subject who had extremely elevated blood cholesterol exhibited a marked reduction of approximately 60 percent when he ate the baked goods containing isolated soy protein for four weeks. In a subsequent study, a significant reduction in cholesterol was observed when men

creasing production efficiency and lowering costs.

At the University of Illinois, novel plant selections with simple, intensely colored, highly stable anthocyanins (one of the five main classes of plant pigments) have been identified and adapted to regulated tissue culture systems. New quantitative methods of pigment extraction and structural determination are used to discover and identify anthocyanins with enhanced stability or elevated color intensity — attributes that favor adaptation of the anthocyanins to food colorants. The rigorously controlled *in vitro* environment is an ideal system for in-depth analysis of the anthocyanin biochemical pathway (see Figure 1). Each variable in the culture regime can be probed and effectively managed in order to maximize synthesis of high-quality pigments, with excellent potential for use as food additives. The opportunity for direct, dynamic control of the physical and chemical microenvironment is a tremendous advantage in the production of superior natural food colorants.



d e f

As an added bonus to this research, some of the precursors produced with the anthocyanins have superb chemopreventive properties. These precursors (identified as tannins, isoflavanones, and flavanones) can lower cholesterol levels, prevent heart disease, and inhibit tumor formation. It is possible to tailor the microenvironment to produce fewer pigments and more tannins, isoflavanones, and flavanones. Therefore, the potent *in vitro* production systems under development may also prove to be a source of valuable pharmaceutical products.

Production of secondary products through tissue culture is still not an economic reality. The success of natural product systems *in vitro* necessitates sophisticated control in order to regulate the many variables that influence production. However, the development of new strategies to constantly monitor and optimize synthesis (such as the emerging machine vision options for process control that allow researchers to view the process on a computer screen) promise to lead toward commercialization of this emerging technology, with lower costs for natural plant products and fewer risks to human health and safety. — *Mary Ann Lila Smith, associate professor of plant physiology, Department of Horticulture; and M.D. Berber-Jiménez, assistant professor of food chemistry, Department of Food Science*

with elevated cholesterol concentrations (greater than 220 milligrams per 100 milliliters of blood) were fed 25 grams of isolated soy protein per day for one month. The effect of 25 grams was not as strong as 50 grams, but nevertheless, the 25 grams of soy protein did effectively lower total and LDL-cholesterol concentrations. In both of these studies, the reduction in blood cholesterol was most likely due to actions of different phytochemicals, present in different amounts in isolated soy protein and soy flour.

Soy Wonder Drug?

Results from these two studies show that soy can be incorporated in moderate amounts into a typical American diet, leading to significant health benefits. Future studies in Potter's laboratory will try to determine the mechanisms of action of soy-related phytochemicals on lipid metabolism. An additional study carried out by Potter in collaboration with Elizabeth Jeffery, of the Institute for Environmental Studies at UIUC, will examine the effect of soy phytochemicals on liver enzymes that detoxify carcinogens. These studies may help to explain the association between consumption of soy and a decreased risk for the development of chronic diseases.

Flax is under investigation in the FFH program because of the foodstuff's potential cancer-preventive properties. Certain fiber-associated compounds in flax called lignans are known to markedly affect circulating hormones and rates of cell division. This may reduce the risk of hormone-dependent cancers of the breast and colon. Phyllis Bowen, director of the nutrition and metabolism research laboratory at UIC, conducted one of the few human feeding studies with flaxseed. Future studies will examine the effect of flax feeding on biological markers of colon and breast cancer in humans at increased risk for the development of these diseases.

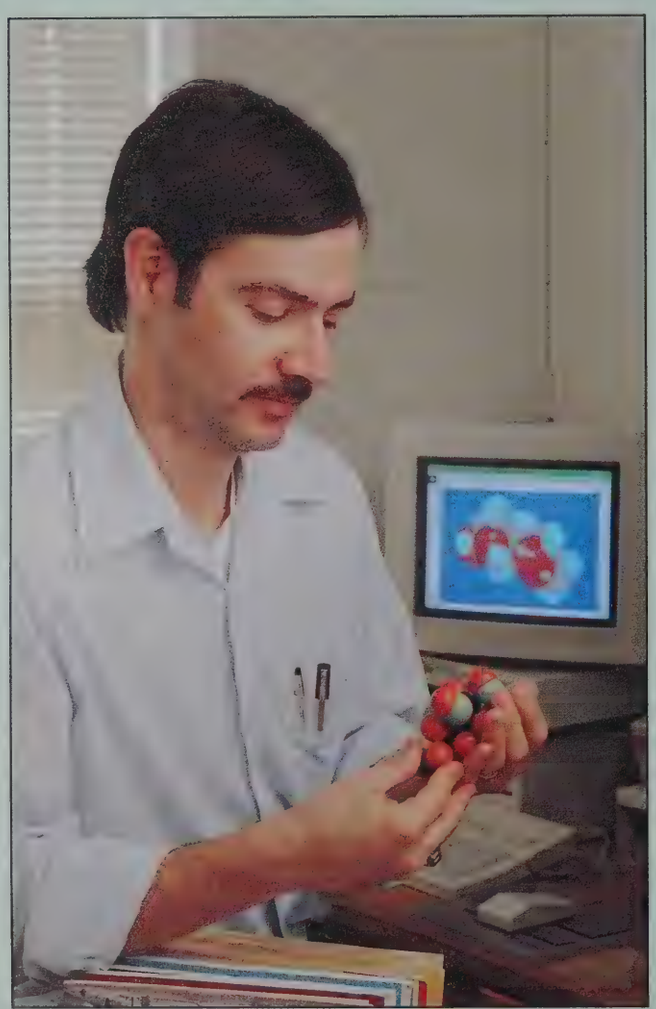
The traditional view that good nutrition means avoidance of classical nutrient deficiency diseases is obsolete. Evidence available from human population studies and clinical investigations and corroborated by experiments in laboratory animals clearly shows that numerous health benefits may stem from the phytochemicals present in edible plants. Look for the Functional Foods for Health Program at the University of Illinois to be at the forefront of this innovative and exciting new area.

Clare M. Hasler, visiting assistant professor, Department of Food Science, UIUC, and the Departments of Nutrition and Medical Dietetics and Medicinal Chemistry and Pharmacognosy, UIC ■

Can Computers Change the Taste of Food?

With the advent of newer, faster, and more powerful computers, it has become possible to mathematically model the structure of molecules and how they interact. Because of the complexity of the calculations required to predict structures and interactions, these calculations have always needed electronic assistance. But in recent times, calculations that just a few years ago needed a mainframe or even a supercomputer can now be done on a desktop personal computer.

There are three kinds of molecular modeling calculations: ab initio, semi-empirical, and molecular mechanics (MM). Ab initio calculations are the most complex because they are derived entirely from theory. MM is derived from experimental observations and, while still complex, is much simplified compared to ab initio calculations. Semi-empirical calculations are a compromise between the two extremes.



The author holds a three-dimensional model of alphamethyl glucoside, which is also on the computer screen. Investigation of methyl glucoside may lead to a better sweetener.

Molecular modeling has been an invaluable shortcut in pharmaceutical and food additive design. Previously, when a useful drug or sweetener was identified and researchers investigated structural possibilities that might optimize the desired effect, multiple series of compounds had to be time-consumingly synthesized. Molecular measurements had to be determined by sometimes difficult procedures like X-ray crystallography. Then the compounds had to be tested, and the cycle started all over again.

With molecular modeling, if compounds having similar effects are known, then the geometry of possible receptor sites can be mathematically modeled, molecules that better fit that receptor can be designed, and their fit can be tested by molecular field analysis. Regions of molecules that are structurally similar can be compared by superimposing the compounds, a procedure impossible except via molecular modeling.

In the Department of Food Science, we have used MM to predict which of a pair of possible polymerizable carbohydrate products from a chemical reaction is most likely to be produced in excess. In addition, we are trying to predict which polymeric structures will most likely degrade quickly.

We are also attempting to understand why structurally similar glycosides taste different. For example, methyl glucoside (crystals used to make resins, drying oils, plasticizers, and surfactants) contains one chemical substance that tastes sweet and a nearly identical substance that is intensely bitter. By taking measurements from molecular models of both compounds, it is possible to understand how they interact with theoretical structures of sweetness/bitterness receptors. One theory is that sweet and bitter compounds interact with the same receptors, but in different ways. If these interactions are understood, it may be possible not only to design better sweeteners (those that taste more like sugar), but also to design compounds that will block bitter or undesired tastes. — *Larson B. Dunn, Jr., assistant professor, Department of Food Science*

Sea Grant's First Decade

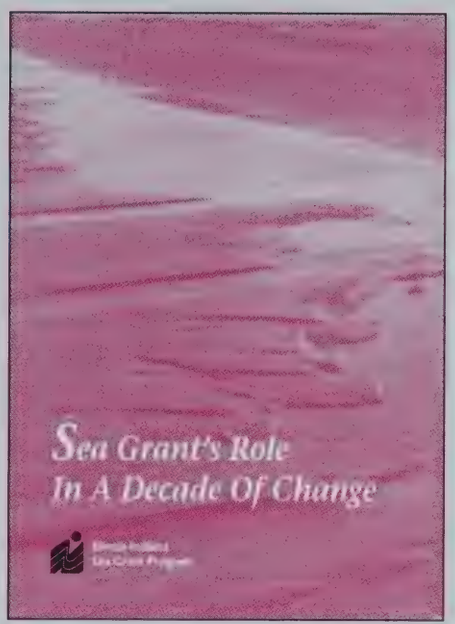
"Sea what?" This may have been a common response when people in the heart of the midwestern prairie first heard about Sea Grant. During the past decade, though, the Illinois-Indiana Sea Grant Program has made an impact.

Sea Grant's Role in a Decade of Change, the just-released report published on the tenth anniversary of the program, describes what Sea Grant is all about. The issues-oriented format highlights Sea Grant's activities in research, marine extension, education, and communications during a time of significant change.

Created in 1966, the National Sea Grant College Program follows the same model as the land-grant university system established in 1862. Illinois-Indiana Sea Grant is the newest of 29 programs in the nation's coastal and Great Lakes states.

Jointly administered by the University of Illinois and Purdue University at West Lafayette, Indiana, the program focuses on promoting the wise use of Lake Michigan and related water resources. Activities are targeted toward increasing economic benefits while protecting the environment.

Current research includes control of zebra mussels — tiny, non-indigenous mollusks that have invaded the Great Lakes and moved into many rivers and streams. The mussels clog water intake pipes and are expensive to remove. Several other research projects are addressing Lake Michigan water-quality concerns.



Through extension activities, Sea Grant provides technology transfer to stimulate economic development and create a more marine-literate public. The effort to promote economic development is illustrated by a waterfront revitalization project. Sea Grant Marine Extension has provided management workshops for charterboat operators and has addressed issues to enhance coastal economics in Lake Michigan's shoreline communities. In response to an increasing interest in aquaculture (fish farming) in the Midwest, the program also helped develop aquaculture legislation in both Illinois and Indiana and is sponsoring workshops on aquaculture operations.

Education activities include promoting wetlands awareness in the public schools by training science teachers. Sea Grant's marine education series, Wetlands Are Wonderlands, continues to spring up in youth education programs throughout the country. Communications activities have included Gulliver the Talking Gull and an interactive exhibit on the Great Lakes presented at various functions, including the Illinois State Fair and the University of Illinois' College of Agriculture Open House.

During the next decade, Sea Grant will focus on marine issues including environmental problems, commercial competitiveness, new product and market creation, natural resource management and enhancement, and aquaculture. In addition, Illinois-Indiana Sea Grant will respond to Great Lakes issues that have yet to surface.

Copies of *Sea Grant's Role in a Decade of Change* may be obtained from the Illinois-Indiana Sea Grant Communications Office, University of Illinois, 65A Mumford Hall, 1301 W. Gregory Drive, Urbana, IL 61801. *—Nancy Riggs, communications specialist, Illinois-Indiana Sea Grant Program*

University of Illinois at Urbana-Champaign
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Illinois Research

Agricultural Experiment Station
Fall 1993

FOOD SAFETY

Myth vs. Reality

College of Agriculture, University of Illinois at Urbana-Champaign, Volume 35, Number 3

Illinois Research

Fall 1993
Volume 35, Number 3

Published quarterly by the University of Illinois Agricultural Experiment Station

AES director: Donald A. Holt

Editorial director: Nancy Nichols

Editors: Terri Stone, Phyllis Picklesimer

Contributing editor: Krista Sunderland

Science writer: Tina Prow

Contributing writers: Lisa Sheppard, Richard Bogren

Art director: Paula Wheeler

Photo director: David Riecks

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This issue of *Illinois Research* is printed on recyclable paper with ink made from soybean oil.

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Cover design and design production for this issue provided by Grace Delcano, UI Office of Publications.

Food Safety

Food Safety: Myth Versus Reality

Early humans collected, produced, and processed their own food. As a natural consequence, our ancestors had direct control of their food supply and its safety. Since that time, industrialized societies have developed a complicated food production and distribution system to support our fundamental need for nourishment. We have come to depend on others for our food and that food's safety.

Although the United States enjoys the safest food supply in the world—with the greatest variety, quality, and lowest cost—consumers are becoming increasingly inquisitive and even skeptical about safety issues relating to how their food is produced, processed, distributed, and served. What it contains, what has been added to it, and what it has been contaminated with have become the subjects of almost daily news reports. There are special-interest and consumer groups whose focus is food safety. In a sense, we are attempting to reestablish the control over the safety of our food supply that we lost when we abandoned the hunter-gatherer and, subsequently, the agrarian lifestyle.

But what does food safety mean? The most important component of food safety is ensuring protection against food pathogens—microbes that cause human and animal disease. Even with the safest food supply in the world, the cost of foodborne illness is more than $5 billion each year in the United States. However, many consumers might be surprised to know that the vast majority of food poisoning originates from faulty practices in the home. Of course, notable exceptions such as the Jack-in-the-Box *E. coli* O157:H7 outbreak do occur and generate national interest. As a result of this single outbreak of foodborne disease, Congress is moving quickly to revise the national meat inspection and safety system.

Although protection against undesirable microbes is very important, food safety involves many other issues. It encompasses animal and plant production methods; control of pesticide and herbicide residues; avoidance of contamination by foreign matter; sanitation systems; packaging, processing, and preparation technology; design of food formulations; safe storage; and awareness of food allergies, toxicology, and nutritional requirements.

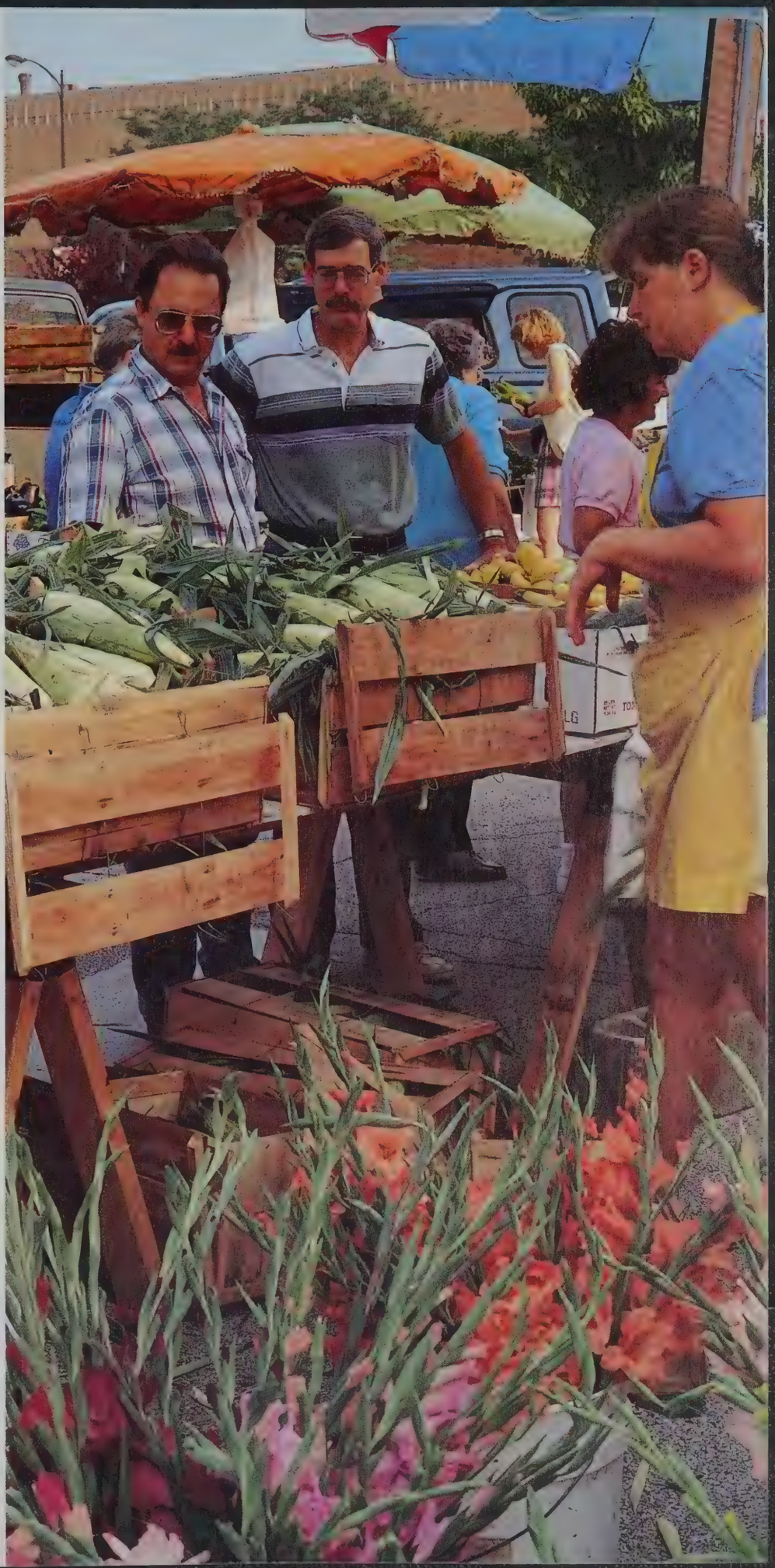
The consumer and the food safety specialist view safety from very different perspectives. The consumer wants a no-risk system. The expert knows that this is impossible to achieve. There is no such condition as zero risk. Thus, experts talk in terms of risk-benefit analysis. For example, the addition of a chemical preservative to a food product provides a significant margin of safety against foodborne pathogens and substantially increases shelf life, but the additive is not necessarily without some small risk. The task is to balance the risks and the benefits. The experts ask, "What is the degree of exposure?" They will seek to quantify the dose and calculate its potential impact. If the gains outweigh the potential negative impact by a thousandfold, then risk-benefit analysis indicates that the additive is efficacious and desirable. The public might be puzzled because the additive does mean some additional health risk. Unfortunately, we have not educated ourselves to think in terms of relative risk—we want oversimplified, all-or-nothing answers.

The Delaney clause that requires the FDA to prohibit the use of a food additive or ingredient known to cause cancer in laboratory animals at any dose is a classic example of well-meaning public policy that is without scientific basis. Toxicologists tell us that "the dose makes the poison." The Delaney clause provides for a zero tolerance. If the standard for additives and ingredients set by the Delaney clause were applied literally to all of the foods we eat, most would be banned. Many foods contain dozens of naturally occurring chemicals that are known to be carcinogens at high dose levels or upon long, cumulative ingestion. Risk-benefit analysis, however, shows that it is better to eat than not eat!

Another misconception concerns the comparative safety of what we perceive as "natural" and the suspicion of ingredients and food additives that are viewed as "artificial" chemicals. In reality, all food is composed of an assorted mixture of chemicals with complex organic chemical structures and diverse pharmacological activities. Approved food additives and ingredients are actually better understood and safer than a variety of "natural" foods and ingredients.

In the final analysis, food safety also depends on a concept called cost-benefit

analysis: Each increase in the safety of the system incurs some additional cost. For example, banning pesticides and herbicides would lead to lower yields and increased crop losses, resulting in increased costs to the consumer. We are unaccustomed to asking whether the improvement in safety is worth the additional cost because we as consumers are interested in an unachievable goal: absolute safety. But we accept risks in many other phases of our lives. There is a far greater chance of being killed or injured in an automobile than being adversely affected by the safety of our food supply. Yet we as consumers readily accept that the cost-benefit analysis shows that building safer cars—though possible—would be far too costly. We need to put risks, benefits, and costs in perspective as we seek new directions in food safety. *—Bruce Chassy, head, Department of Food Science, and John Erdman, director, Nutritional Sciences Division, Department of Food Science*



Authors Bruce Chassy (left) and John Erdman (center) examine the produce at a farmers' market in Urbana.

Bringing Food-Service Safety to the Table

Jim Painter

Unlike many of the problems on the nightly news, food-service safety is a concern of the overwhelming majority of North Americans. Economic problems are regional, crime seems to happen to other people, and recent wars have been half a world away. But when a foodborne illness outbreak occurred at a fast-food restaurant chain in the Pacific Northwest, it received nationwide coverage. Although heart disease and lung cancer are recognized, potent killers, our fat consumption remains high and many of us still smoke. Yet within a few months of the Pacific Northwest outbreak (during which 500 people became ill and four children died), the federal government and the state of Illinois issued new guidelines for the cooking temperature of ground meat. Why such an interest in food safety?

The answer is multifaceted. The United States is a fast-paced society that wants quick results. Problems such as heart disease and cancer develop over a long period of time and have complex and sometimes unidentifiable origins. Conversely, foodborne illness has a rapid onset and a definable cause. The number of deaths per year associated with foodborne illness in this country are small compared to those from heart disease and cancer (an average of less than 30 and tens of thousands, respectively), but foodborne illness deaths seem to be within our power to prevent.

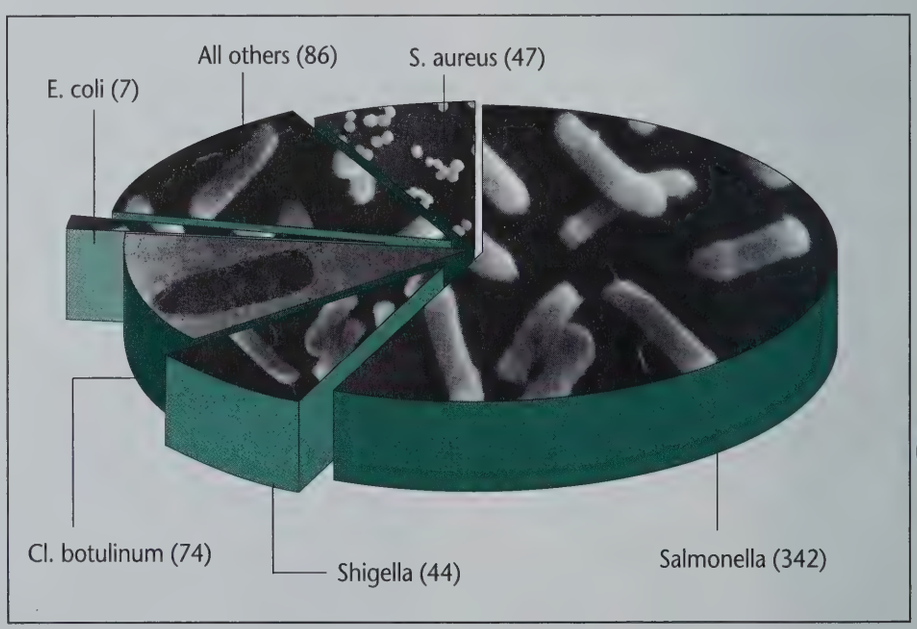
Food-service safety is also a major concern because Americans are eating more of their meals away from home. At the turn of the century, only 3 percent of the family food dollar was spent on food away from home; within the next few years, it's estimated that this number will reach 50 percent. Over one-third of all food eaten away from home is consumed at fast-food restaurants. No wonder a foodborne disease outbreak in a fast-food restaurant causes great concern.

Sources of Disease

Foodborne disease is caused by bacteria, chemicals, parasites, and viruses. Bacteria are responsible for the majority of outbreaks. Bacteria also produce more severe disease; of the 137 reported deaths in the United States caused by foodborne disease from 1983 through 1987, one was of a parasitic origin, one viral, three chemical, and 132 were of a bacterial origin. *Salmonella* was responsible for a majority of the bacterial outbreaks in this period, followed by *Clostridium botulinum, Staphylococcus aureus,* and shigella. *Escherichia coli* accounted for only seven of the 909 foodborne outbreaks reported during this period.

It's important to note that bacteria in the food supply is not necessarily a problem. Bacteria are naturally present in all fresh-food products. A large pecentage of the chicken sold in this country contains salmonella, yet, with proper food-handling practices, chicken can always

Confirmed Foodborne-Disease Outbreaks Caused by Bacterial Agents (1983–87)



Preventing the Unwanted Dinner Guest

Keep hands clean. Cook food thoroughly. Store food properly. These three food safety rules, if practiced in all eating establishments and homes, could prevent most of the millions of foodborne illness cases that occur in the United States every year. These simple practices might have prevented the deaths of four people who fell ill to bacterial food contaminants last January.

In a major outbreak that spanned four western states, more than 500 people became ill and four people died from bacterial infections after eating tainted hamburgers at the Jack-in-the-Box restaurant chain. These people suffered symptoms ranging from bloody diarrhea and intense abdominal pain to irreversible damage to the intestine and kidneys.

The hamburger patties were contaminated with a rare strain of *Escherichia coli,* a coliform bacteria that produces a harmful toxin when ingested.

Many strains of this bacteria are naturally found in animal intestines, so it is not uncommon that low levels of *E. coli* will be present in meat, especially ground beef. However, the organism responsible for the outbreak, O157:H7, is not usually found in animal products. Meat contaminated with this strain is considered unacceptable by government standards.

When investigating the outbreak, the Food Safety Inspection Service (FSIS) recovered four lots of meat that tested positive for the bacteria. Officials traced the meat supply to farms and auctions in six western states, but no one slaughter plant or farm was identified.

"We may never know where the meat came from and how it became contaminated," says Jill Hollingsworth, FSIS assistant to the administrator.

The search for the source of contamination may have been unsuccessful, but the agency concluded that improper meat handling at the other end of the food chain—the restaurants—played a major role in the illness outbreak. Illness may have been prevented if the beef patties had been cooked properly.

E. coli is completely destroyed by high temperatures. Ground beef should always be cooked until the meat is no longer pink and juices run clear. Restaurant workers at the fast-food chain failed to cook hamburgers to a temperature high enough to eliminate pathogens. As a result of the outbreak, the Food and Drug Administration recommended that the national code require a final product temperature of 155°F (the previous requirement was 150°F).

"Foodborne illness is entirely preventable," says Susan Brewer, University of Illinois Extension food safety specialist. "Since there is no way to produce animals with zero microbial contamination, we rely on safe handling and cooking procedures to eliminate harmful bacteria from foods we eat."

Consumers should assume that meat and other animal products contain bacteria and should follow safety recommendations for handling food. People who are most susceptible to foodborne illness—the elderly, children, pregnant women, and people who have suppressed immune systems—should be especially careful about food safety practices.

"The recent outbreak reminded us that safe food handling can be a matter of life or death," Brewer concludes.
—Lisa Sheppard, Extension communications specialist, Office of Agricultural Communications and Education

If a restaurant cannot provide a meal in a clean dining room, served by neat and clean food-service staff, it probably does not have a clean, sanitary kitchen.

be served to the public in a safe and wholesome manner. The food-service operator—and the public—should be most concerned with contributing factors. These factors include proper temperature in cooking or holding, proper personal hygiene, and kitchen sanitation.

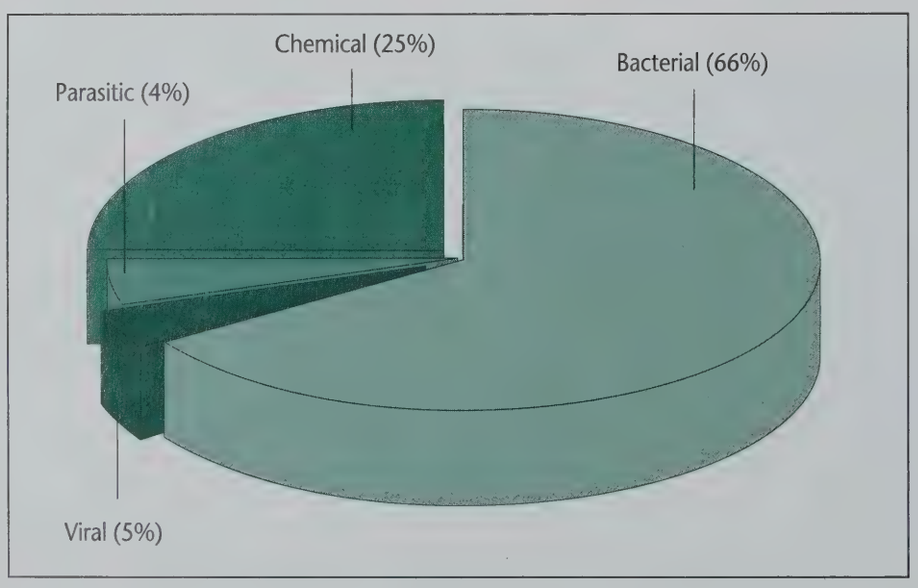
What Makes an Outbreak?

Outbreaks of foodborne illness tend to increase during the warm summer months and occur least frequently during the winter months. Many foodborne diseases are associated with a small segment of the food supply. Chemical toxins such as ciguatoxin and scombrotoxin, responsible for one-half of all reported chemical poisonings, are exclusively associated with fish, while bacterial agents are closely associated with meat, eggs, and dairy products.

Certain regions of the country show higher incidence than the average. In the early 1980s, there was an unusually high incidence of salmonella in New England. During the past decade, the mid-Atlantic states and some southern states have also shown an unusually high number of foodborne disease cases caused by this bacteria. Salmonella has long been associated with improper handling of poultry, but recently eggs have also been implicated. Many governmental agencies and private companies are suggesting or mandating that food containing eggs not be served unless the food has been thoroughly cooked.

The number of individual cases and outbreaks varies greatly from year to year. Although it appears that foodborne outbreaks are lessening, no valid conclusions can be made because of the type of data available. The best information available is from the Center for Disease Control and is based on information voluntarily reported to them by state and federal government offices. Many times the fluctuation in total number of incidents reported is due more to time pressure on the government offices than on the actual change in number of cases.

Percentage of Foodborne Disease by Etiological Agent (1983–87)



With these limitations in mind, there are a few major changes in the incidence of individual disease agents. Bacteria such as *Clostridium botulinum,* though found in home-canned foods, are rarely seen in commercial establishments that buy food through approved vendors. Other agents such as *E. coli* have surfaced as great problems in the food industry in recent years. Foodborne disease caused by salmonella showed a steady increase over the past 30 years until 1985. The recent decrease may be attributed to the overwhelming demand of AIDS on the governmental public health agencies and not on an actual decrease.

A Plan for Prevention

It's impossible to inspect every step in the food-production process at all times, so a system was implemented to check the process at periodic critical points. The system is called Hazard Analysis Critical Control Points (HACCP) and was developed in 1971 for NASA by the Pillsbury Company to ensure safe food for the space program. For example, the HACCP says that hamburger patties should be monitored for proper temperature during storage and internal temperature during cooking. If these critical control points are monitored closely, hamburger patties may be served free of bacterial contamination.

The food-service industry can greatly reduce the amount of foodborne disease by monitoring time and temperature of the food during processing and by inspecting the personal hygiene of employees at critical control points. The public can also protect themselves by being informed and watchful consumers. If a restaurant cannot provide a meal in a clean dining room, served by neat and clean food-service staff, it probably does not have a clean, sanitary kitchen.

Safety Is More Than Sanitation

Food safety is not limited to foodborne disease. For example, monosodium glutamate (MSG), a food additive used as a

The author instructs Steve Kovachevich, senior in restaurant management, as he prepares for a buffet in Bevier Cafeteria. The cafeteria is open to the public and is completely managed by students.

flavor enhancer, was found to cause a sometimes serious condition in susceptible individuals. This condition is characterized by flushing of the face, dizziness, headache, dry mouth, and nausea. Although MSG is safe for most people and is used in many products, some consumers have chosen to restrict it in their diets.

More recently, it was discovered that sulfites produce severe reactions in susceptible individuals. Sensitive people, particularly asthmatics, can experience nausea, diarrhea, and in a few cases death. Yet sulfites play an important role in the processing of some fruits and vegetables. Dried fruits such as peaches, pears, and apricots are products often treated with sulfites to preserve their bright colors. Without sulfite, these fruits would turn a dark brown after drying, and many consumers would not eat them. Currently, sulfites are banned for use by commercial food-service establishments but may still be used by manufacturers on certain foods.

Current research in the area of food-service safety focuses on the control of bacterial contamination. The most promising technology available in the quest to provide food free from *E. coli*, salmonella, and other bacterial agents is food irradiation.

Food irradiation is not a new technology. It was approved for use on wheat products and potatoes in the mid-1960s, yet never used commercially. Although irradiation of fresh produce was permitted in the mid-'80s, it's only in the last two years that a limited number of irradiated produce items have been sold in retail outlets. Irradiated produce at an outlet in Northbrook, Illinois, includes strawberries, mushrooms, and tomatoes.

Irradiation was approved for poultry products in October 1992, but producers are hesitant to use the procedure because of consumers' perceptions of "radioactive" food. Beef and seafood are currently making their way through the approval process, and final rulings are expected in late 1993 or early 1994.

Relatively small doses of irradiation reduce bacterial pathogens in meat and poultry to virtually zero. Food-safety studies that were conducted over the last three decades have led the FDA to approve the irradiation of many food products. However, some consumer groups are still not convinced of its safety, and three states have banned the sale of irradiated foods.

Food-service operators have a responsibility to provide safe, wholesome food to the customer in an attractive, palatable, and nutritious manner. These goals are not always easy to achieve. For example, when the nutritional content of a food is improved by decreasing the fat content, the food often becomes less palatable—think of the difference between premium ice cream and ice milk. The issue is also complicated because what is acceptable for one person may not be suitable for another. It's up to the food-service operator and the consumer to find the proper balance.

Jim Painter, teaching associate in Food Service Systems, Quantity Foods Laboratory manager, Division of Foods and Nutrition

Naturally Occurring Toxins: Part of a Balanced Diet?

Tina Prow

Nature brings a variety of chemicals to the table—by some estimates, many times more than humans could add to foods. Consider typical morning beverages: Coffee drinkers are exposed to more than 800 chemicals that occur naturally in coffee. At least 16 of the 21 chemicals tested to date are carcinogens. Researchers expect a typical cup of coffee to contain about 10 milligrams of rodent carcinogens.

If comfrey is your cup of tea, you consume pyrrolizidine alkaloids that cause cancer in rats. If you reach for orange juice, count on getting valuable vitamin C, but also D-limonene, a rodent carcinogen. Scientists estimate 125 compounds occur naturally in apple juice; of the five tested, three are carcinogens.

Americans eat about 1.5 grams of natural pesticides per day —10,000 times more than manufactured pesticides, according to Bruce Ames, a professor of biochemistry and molecular biology at the University of California, Berkeley. One of the most outspoken researchers investigating plant toxicants, Ames contends that Americans eat 5,000 to 10,000 different natural pesticides and their breakdown products.

These naturally occurring chemicals are necessary for plant survival. They help plants withstand and fend off fungi, viruses, insects, and animal predators. Although researchers have tested only a few plant toxins for carcinogenicity, the mounting evidence prompted Ames to write in a 1990 journal article that "it is probable that almost every fruit and vegetable in the supermarket contains natural plant pesticides that are rodent carcinogens."

University toxicologist Elizabeth Jeffery prepares samples for analysis in her lab at the UI Institute for Environmental Studies.

Dining Dilemmas

Anise, apples, bananas, basil, black pepper, broccoli, brussels sprouts, cabbage, cantaloupe, carrots, cauliflower, celery, cinnamon, cloves, cocoa, coffee, cooked meats, fennel, grapefruit juice, honeydew melon, horseradish, kale, lettuce, lima beans, mangos, mushrooms, mustard, nutmeg, orange juice, parsley, parsnips, peaches, pineapples, potatoes, radishes, raspberries, strawberries, tarragon, tea, and turnips are just a few of the beverages, spices, and foods known to have naturally occurring carcinogens.

Far from making a meal a dubious dining experience, however, many of these and other foods that likely have toxins are important to a balanced diet, according to Clare M. Hasler, coordinator for the University of Illinois Functional Foods for Health (FFH) program. One component of FFH is focused on how plant chemicals that protect plants from viruses and pests affect human health.

In fact, if health is a motivating factor in food choice, the diet change many people should make is to eat even more fruits and vegetables, she advises. Although these foods have naturally occurring toxins, researchers are finding that they also have disease-preventing and health-promoting benefits. For instance, small doses of certain toxicants also appear to act as antioxidants in the body. Antioxidants have been shown to protect against cancer by preventing cell damage that can lead to cancer.

Also, the human body has mechanisms for "detoxification" of natural or synthetic chemicals, Hasler adds. For instance, cells in the mouth, esophagus, stomach, intestine, colon, skin, lungs, and other areas that are exposed to toxins shed continuously.

In addition, the liver and intestinal cells have enzyme systems that become active when exposed to foreign compounds. These enzyme systems metabolize the compounds and then excrete them in a nontoxic form.

DNA in the cell also acts as a defense mechanism when it repairs itself after exposure to certain chemicals, including those chemicals that are naturally present in fruits and vegetables.

Detoxification and antioxidants explain in part how a diet high in fruits and vegetables that contains naturally occurring toxicants can be associated with lower rates of cancer.

"While naturally occurring plant toxicants in fruits and vegetables have destructive properties, there is overwhelmingly strong evidence that [these foods] can be protective against disease, depending on the dose of the compound," Hasler says. "So some of the old nutrition advice is still the best advice: 'eat a variety of foods' and 'everything in moderation.' A wide variety of foods in the diet can aid in favorably altering the balance between naturally occurring toxicants and anti-toxicants."

The Dose Makes the Poison

The adage "the dose makes the poison" can apply to naturally occurring toxins in plants. A number of studies show that while a certain amount of a carcinogenic compound may have a killing effect on human cells, a smaller amount may have no effect or a protective effect.

For example, the naturally high levels of cyanohydroxybutene (CHB) found in such cruciferous vegetables as cabbage and brussels sprouts are toxic to cells in the pancreas and liver. CHB forces cells to go through a programmed cell death similar to normal cell death that occurs as the body revitalizes itself: as functions within the cell shut down, the cell shrinks and eventually is engulfed by other cells.

Intrigued by the way CHB kills cells, a UI team is studying the effect of low doses of the chemical compound on cancer cells. Preliminary laboratory data indicate that these cells are more susceptible to programmed cell death from CHB than are normal cells. If it's proved that CHB provides significant chemoprotection against cancer, a possible future step might be for geneticists to increase CHB in vegetables.

It is probable that almost every fruit and vegetable in the supermarket contains natural plant pesticides.

"What's happening in foods research is very exciting," says team member Elizabeth Jeffery, a toxicologist with joint appointments at the UI Institute for Environmental Studies, Veterinary Biosciences, Nutrition Program, and College of Medicine. "Beyond answering nutritional needs, foods have other nonnutritional components that have effects on the body. In the case of CHB, we started with something that looks toxic, but found something that possibly protects against pancreatic cancer."

Normally, no one would eat the high amount of vegetables necessary to take in toxic amounts of CHB, Jeffery notes. Neither would they eat the amount that would give them the beneficial "low" CHB dose used in UI studies—about one pound of brussels sprouts per day, every day. Furthermore, she suggests, those who dislike brussels sprouts should not force themselves to eat an extraordinary amount of it, or any other food, solely to prevent cancer.

"If you don't like brussels sprouts, don't torture yourself by eating them just for cancer prevention. You can't eat enough for that purpose," she advises. "The key to cancer prevention is unlikely to be in the one single food that makes headlines on one particular day—that's a simplistic approach to a very complex problem. Instead, the best strategy is to have a balanced, sensible, varied diet. That way, the likelihood of reaching toxicity levels from food becomes small."

That diet choices can be important is borne out in a study Jeffery is conducting on the interaction of caffeine and acetaminophen, a pain reliever. Considered a safe product at recommended doses, acetaminophen can have a fatal effect on the liver at about 70 tablets per day. Jeffery's study indicates that caffeine greatly aggravates the toxic effect of acetaminophen so that smaller doses become toxic. The results raise questions about whether there are other nonnutritive food components that have the same effect.

"This study shows that it's important to look at interactions," Jeffery says. Future research in her laboratory may focus on toxicity of acetaminophen in combination with some chemicals found in fruits and vegetables.

Redefining Cancer Risk

Knowing more about foods and the risk they pose is a concern of Robert J. Scheuplein, a toxicologist with the Food and Drug Administration. Although laws passed in 1958 require the FDA to approve food and color additives prior to marketing, the agency has virtually no authority to approve "traditional" foods or to test for naturally occurring toxins, he says.

"Ordinary, wholesome food was always considered perfectly safe. It was those things that were 'bad'—meaning additives, residues, and contaminants—that we had to watch for, and that's what the laws address," he says. "Now we're finding out that there are more natural toxins in food than we might ever think of adding. They've always been there and probably don't constitute a hazard to most people under most circumstances, but we know that diet can be a factor in exacerbating potential for carcinogenicity."

One issue Scheuplein grapples with is risk from synthetic chemical residues and additives compared to risk from naturally occurring toxins. A celery variety developed in the late 1980s focused attention

on the question of whether natural pesticides are "safer" than synthetic pesticides. The new, highly insect-resistant celery variety reduced the need for chemical pest control. Considered a plus by those worried about use of synthetic chemicals on foods, the celery raised a red flag among those concerned about naturally occurring toxins in foods. Bruce Ames reported that the new variety had 6,200 parts per billion of carcinogenic psoralens, compared with 800 ppb found in other celery varieties.

The light-sensitive "natural" pesticide caused rashes and burns on celery handlers when they went out into sunlight. Those problems could be solved through handling procedures, but the incident represented a dilemma that remains: Should scientists breed plants with higher natural pesticides to eliminate any need for synthetic chemicals, or should they instead turn their efforts toward reducing naturally occurring toxicants in plants that then would be treated with synthetic chemicals if pest problems developed?

Scheuplein suggests that, although important, the ongoing debate over the merits and dangers from synthetic versus naturally occurring pesticides is secondary to the related problem of opportunity for exposure.

"The sheer volume of toxins in foods is so great that there really is no question that we should be looking at the broad pattern of food intake," he says. "When we consider exposure, synthetic pesticide residues is probably not where the human health risk from toxins is.

"What the risk argument brings into focus is that risk assessment really needs to be improved. It seems evident that we're going to find carcinogens in whatever we check, so finding them is not necessarily a useful process."

In fact, he adds, standard risk assessment yields questionable results when applied to fruits and vegetables. "The amount of one chemical in lettuce presents a one in 1,000 risk for cancer. I do not believe that number," he says. "It hasn't changed my salad-eating habits."

Changing eating habits as more is known about cancer and foods is one way to reduce the cancer deaths attributable to diet. UI researchers Richard Doll and Richard Peto linked diet to approximately 35 percent of cancer deaths in a risk table published in 1981 and considered valid today, according to Scheuplein.

"We don't know how to 'avoid' naturally occurring toxins. Basically, we know that macronutrients, like fat, can modify the expression of cancer, so we need to learn more about how the factors modulate the expression of cancer," Scheuplein says. "The research that would allow us to do that has not been done. But even small increases in knowledge that become behavior changes in the way people eat could have long-term beneficial effects on the quality of life and health."

Tina Prow, science writer, Agricultural Experiment Station

Scientists Debate Method for Identifying Human Carcinogens

If a substance is found to cause cancer in rodents, can one assume that it will also cause cancer in humans? Not necessarily.

A number of factors affect the reliability of tests to identify carcinogens. In rodents, chemicals are tested at the "maximum-tolerated dose," which gives no information about the effects of these compounds at low-dose exposure, as would typically be the case in humans. In addition, laboratory animals are relatively homogenous and are studied under strictly controlled conditions, whereas humans are quite heterogenous, varying from person to person with respect to genetic constitution, diet, lifestyle, and so on. Furthermore, the rodent assay was developed based on observations made with extremely potent chemicals (for example, aflatoxin and radiation) that damage DNA and therefore do cause cancer at low doses. We know that there are many agents that can cause cancer at high doses but do not damage DNA and therefore probably do not pose a risk at low-dose exposure.

It's a complex issue, particularly given today's technology and our current understanding of mechanisms of carcinogenesis. Unfortunately, though there are a number of problems with the use of the rodent bioassay for predicting human cancer risk, there is as yet no satisfactory substitute for the long-term testing of chemicals. Scientists are currently reevaluating much of the existing rodent carcinogenicity data, taking into consideration low-dose exposure and mechanistic factors in order to more realistically estimate human risk from rodent carcinogens.

—Clare M. Hasler, visiting assistant professor, Department of Food Science, UIUC, and the departments of Nutrition and Medical Dietetics and Medicinal Chemistry and Pharmacognosy, UIC

UI Researchers Target Aflatoxin

University of Illinois scientists Don White and Jack Widholm are using naturally resistant corn hybrids and genetic engineering to prevent aflatoxin from forming on corn. Aflatoxin, one of the most carcinogenic compounds yet discovered, is found on the seeds of crops such as corn or peanuts when the fungus *Aspergillus flavus* is present. When the aflatoxin is ingested by animals or by humans, it can be activated so that it binds to the host DNA to exert its carcinogenic properties. It can also cause liver damage.

Problem levels of aflatoxin do not often occur in Illinois except in years of weather-induced stress such as drought. If conditions are right, the toxin can develop both before harvest and after the grain is in storage. When aflatoxin does affect a crop, it is a dangerous and costly problem. Because it is so dangerous, corn used as food for animals and humans is always monitored closely for its presence. If levels above 20 parts per billion are found, the grain cannot be sold to grain elevators. Corn with somewhat higher levels can be fed to breeding and feeder cattle and swine.

The first approach being used by White to eliminate aflatoxin from corn involves identifying corn lines that are naturally resistant to the *Aspergillus* fungus. Many different corn hybrids are being screened by damaging the kernels with pins and injecting *Aspergillus* under the husk. Hybrids that had very little fungal growth have been identified. None of the naturally resistant lines are commercial hybrids, but the natural resistance can be transferred into commercial inbred lines, which can then be used to make commercial hybrids.

Researchers are also using genetic engineering to prevent *Aspergillus* growth on corn kernels. Genes that code for two different fungus-destroying enzymes have been isolated. The genes are modified so that they will be expressed at high levels in the seed and then placed back into the corn. To do this, a particle bombardment technique is being used. Very small metal particles, coated with DNA carrying the modified genes, are propelled at a high rate of speed by either a gunpowder charge or high-pressure gas acceleration. After the particles have penetrated the corn tissue culture cells, transformed cells can be identified by a marker gene that is also on the DNA. High levels of the enzymes should be toxic to *Aspergillus,* preventing growth and aflatoxin formation. These enzymes may also be effective in eliminating the fungus in stored grain. — *Jack Widholm, plant physiologist, Department of Agronomy*

Plant physiologist Jack Widholm uses a "gene gun" to propel modified genetic material into corn tissue culture cells. The genes should help prevent the growth of Aspergillus flavus, *the fungus causing aflatoxin.*

From Harvest to Home: Food-Processing Safety

J.G. Hawkes and W.E. Artz

The safety of the food supply is an important concern to all consumers. In the United States alone, millions contract a foodborne illness each year. The food-processing industry and regulatory agencies play a crucial role in improving the safety of the food supply without compromising its quality. This balancing act is complicated by increasing consumer demands for healthy yet safe food, a growing supply of innovative convenience foods, and rising numbers of imported specialty foods.

Unfortunately, safety and quality do not necessarily go hand in hand. Food safety and the protection of the consumer is the food industry's most important goal. From a microbiological point of view, this goal involves ridding foods of pathogens, which is a relatively simple task, traditionally accomplished by subjecting the food to thermal processing, one of the oldest technologies in the industry. However, reducing pathogens does not necessarily result in high quality.

Toxicological safety of foods is also a concern. This aspect of safety may involve the presence of chemicals added to the food, whether intentionally in the form of "food additives" (chemicals approved for food use) or unintentionally in the form of environmental contaminants (for example, pesticides or microbiological toxins). Other toxicological problems may result from interactive chemical changes between the food and the packaging material or thermally accelerated chemical changes during processing of naturally present components. Such chemical changes may result in lower nutritional value or the production of undesirable compounds. General quality attributes such as flavor, aroma, color, or texture may also suffer from severe thermal processing. It is therefore

More than a Century of Concern

Nicholas Appert is generally acknowledged as the inventor of the food-canning process in the early 1800s. He developed the process for the general preservation of foods with little knowledge of its microbiological, chemical, or nutritional implications. It was not until 1864 that the scientific basis for the success of Appert's process was explained by Louis Pasteur, who found the relationship between food spoilage and microorganisms. Several decades of worldwide research followed, and by the 1920s, the first scientifically based method for the calculation of minimum safe sterilization processes for canned food sterilization was conceived.

Chemical safety of foods was an issue as early as 1877, when a regulatory agency in France became concerned about the adulteration of canned peas. At that time, Pasteur was an adviser to the French Board of Hygiene and Sanitation, and he determined that the preservation of the green color of canned peas was dependent upon the addition of copper salts. He recommended that the canned peas have labels stating the reasons for and levels of the addition. Pasteur also investigated a process for the preservation of meats that used benzoic acid. Although little was known at that time of the benefits of the process, he again emphasized that the consumer should be alerted by a label that declared the presence of the additive.

It is clear that many of the food industry's common practices had scientifically uncertain foundations when they were initiated. However, technological developments based on sound scientific facts related to nutrition, microbiology, and chemistry form the basis of our current safety programs.

important to subject a food to the absolute minimal heating time at the temperature that will kill pathogens yet minimize other deteriorative changes.

While microbiological and toxicological safety are of more immediate interest to the food industry, long-range concerns about nutritional value are now becoming an important safety issue, rather than simply a quality issue. This emphasis is particularly significant for consumers who have lower incomes or are less educated in terms of nutrition (which may be a relatively large segment of the population). For those groups, as well as for the general public, it is the moral responsibility of the food manufacturer to supply nutritious and wholesome foods.

There are several factors that play an important role in nutritional safety or efficiency: environmental factors in food production; genetic composition; proper storage and handling; proper control of processing techniques; and proper food enrichment techniques. To encourage nutritional safety, the Food and Drug Administration recently has established new nutritional labeling requirements for the food industry to follow.

These operators are practicing food-processing safety during a spray dehydration test run at the University of Illinois's Department of Food Science pilot plant. Operators are wearing protective gear, including hair nets, gloves, and skid-resistant soled shoes. Note that food-contact surfaces are stainless steel and food-grade chemical-resistant polymer tubing.

Good Manufacturing Practices

More constraints, self-imposed or required by governmental regulatory agencies, are being placed on the handling of food products in the food industry. High standards are set for food products in areas such as content and storage life to ensure customer satisfaction and safety. Standards for things such as appropriate labeling and ingredient listing must meet legal criteria. Additional constraints faced by the food industry include availability and costs of energy and nonrenewable resources, cost of commodities and labor, and limits of productivity.

From the farm to the home, one of the most important locations on the food path is the processing plant, from the point that the raw material is received to the point at which the product is safely packaged and leaves the plant. In fact, the food company is also responsible for the safety of the product after it has left the plant, up to the expiration date indicated on the label. These shelf-life predictions are a result of rigorous, accelerated testing techniques performed in laboratories. In order to meet safety standards in food production, a set of minimal requirements, referred to as Good Manufacturing Practices (GMPs), were set forth in 1969 for the food industry to follow. Although the GMPs are intended as general guidelines, there are a few areas of specific requirements, the first and probably most important of which relates to processing of canned low-acid foods. More specifically, the canning industry mandated regulations for the destruction of *Clostridium botulinum* for consumer safety. These GMPs required all commercial processors of canned low-acid foods (for example, vegetables or meats) to register their plants and file processing times and temperatures with the FDA. This requirement applies to both domestic plants and foreign companies that import canned products into the United States.

In the case of canned acidified foods (pH < 4.5), accomplished by the addition of acids or acidic ingredients, accurate analysis of pH was mandated as absolutely critical. The GMPs also specify that all foods with water activity greater than or equal to 0.85 must be thermally processed. (All known bacterial pathogens have a minimal water activity of 0.85 for growth. *Cl. botulinum,* for instance, must have a water activity of ≥0.93 for growth.)

GMPs have been taken for granted in all the leading U.S. food industries. However, implementation of such standards does not proceed without complications. For instance, an established company that wants to fulfill GMPs may be faced with a major expense in updating equipment. General attitudes of plant managers are also an important consideration: they must consider the profitability of the product, but they also need to be concerned about what goes on in the plant to ensure safe food. Another obstacle is that understaffing of government regulatory agencies may inhibit routine inspection. On the other hand, there are certain series of checks and balances. Consumers will either take legal action against a negligent company or simply stop buying inferior-quality products. Furthermore, food companies feel a certain moral obligation and a need to maintain ethics in producing safe, good-quality foods.

Advances in techniques and equipment are imperative if the industry is to provide high-quality, safe foods.

A Preventive Approach to Safety

GMPs allow a great deal of leeway in terms of rules and regulations to be followed by the food industry. A more rigorous approach to the processing of foods with absolute safety built in is to apply a "zero-defect" program known as HACCP (Hazards Analysis/Critical Control Point). HACCP is an integrated, in-process systems control approach to ensuring the safety of food products that has brought about major changes in the food industry's focus in the past five years. The concept of HACCP originated during the early years of NASA's space program to ensure absolute safety of the astronaut's food supply.

HACCP uses a totally different approach to food safety than the GMPs. Traditionally in a food company, raw materials are accepted and the level of defects is determined to adjust how vigorously the materials should be processed in order to meet the processors' finished product specifications. HACCP, on the other hand, focuses on preventing the problems in the first place. The HACCP systems approach first identifies the potential hazards at every process stage, from the raw materials to probable conditions during processing, storage, distribution, and preparation for consumption. Then the HACCP system assesses the probability of these hazards affecting the safety of the finished product. Finally, the system identifies the critical control points (CCPs) where risk is controlled. For example, the first CCP would be in acceptance of the raw materials from the supplier.

Summary guidelines for implementation of HACCP in the food industry have been published in J. Mahone's *The Edible Revolution* (1993). The basic seven principles of HACCP as outlined by the National Advisory Committee for Microbiological Criteria for Foods are listed below.

1. Assess the hazards and risks associated with growing and harvesting; raw materials and ingredients; processing/manufacturing; distribution and marketing; and preparation and consumption of the food product.
2. Determine the Critical Control Points (CCPs) required to control the identified hazards.
3. Establish the critical limits and/or prescribed tolerances that must be met at each identified CCP.
4. Establish procedures to monitor each identified CCP.
5. Establish corrective action to be taken when there is a deviation identified via the monitoring of a CCP. (This must be more than just a "notify supervisor" or "hold for Q.A. disposition.")
6. Establish effective record-keeping systems that document the operation of

Additives Add Up to Good Food

Food additives play an important role in maintaining a high-quality, nutritious, safe food supply and are of little risk to our health. The Food and Drug Administration (FDA) defines food additives as "any substance other than the basic foodstuff which is present in food as a result of any phase of production, processing, packaging, or storage."

Over 140 pounds of food additives are consumed per capita each year. Sugar (sucrose), salt (sodium chloride), corn sweeteners (corn syrup, dextrose, fructose), black pepper, baking soda (sodium bicarbonate), mustard, and vegetable colors constitute at least 98 percent by weight of all food additives used. Flavoring accounts for less than 1 percent by weight.

Food additives can be divided into two categories—direct and indirect. Direct additives are chemicals added intentionally to food to achieve a definite purpose. About 2,800 substances are intentionally added to foods. Indirect additives are substances that are not intentionally added to food but become a part of the food as a result of growing, processing, storage, or packaging. Examples of indirect additives include pesticide residues, animal drug residues, processing aids, plant growth regulators, and packaging components. FDA has set safety limits for both direct and indirect food additives.

A direct food additive is is an additive used for one or more of the following reasons:

- To maintain or improve nutritional value; for example, vitamin D added to milk
- To improve food appearance, flavor, and texture; for example, coloring of maraschino cherries
- To maintain freshness and increase shelf life; for example, calcium propionate to delay bread molding
- To aid processing and preparation; for example, phosphate additives in instant pudding
- To improve safety; for example, nitrite in processed meat products

Federal law states that food additives cannot be used to replace good manufacturing practices or to deceive the consumer by disguising inferior quality.

the HACCP plan: what to monitor, frequency, sampling size, and procedure; who is responsible; and what to record and on what record.

7. Establish procedures for verification that the HACCP system is working.

Keep It Clean

To sustain proper conditions in food plants, the food industry must implement some sort of sanitation regulations in plants and maintain correct processing controls. Proper plant design and construction that follow GMPs are basic criteria for good sanitation. For example, sufficient space must be allocated for installation of equipment and storage of materials according to certain specifications. Any process areas where food and food-contact surfaces are exposed must be subjected to proper sanitary conditions. Adequate lighting, ventilation for clean air, and protection against pests (including insects, rodents, and birds) must be provided.

It is also essential that equipment be of a sanitary design with a proper finish (for example, stainless steel, glass-lined, titanium, or nickel-chromium alloys) for easy cleaning and limited contamination or corrosion. All surfaces that come in contact with food should be considered, particularly pipes, valves, and joints. Seals, for example, must be nonabsorbent, nontoxic, nonexuding, and odorless. In the case of CIP (clean-in-place) systems, proper stations for periodic inspection must be provided.

There also should be proper sanitizing and cleaning (generally with chlorine or steam) of equipment or any surfaces in contact with food. These procedures must be safe for use by workers, should not interfere with final flavor and odor of the product, and should be easily rinsed off, leaving no toxic residue.

Personal hygiene is a critical area of concern and must be monitored continually. GMPs require routine physical exams. Hand-washing policies should be enforced, and gloves are required when handling food. Hair nets and clean clothing and the absence of any jewelry are a necessity when handling food or operating any equipment in a food area.

Sanitation is also required in packaging and storage areas. Individual companies may provide on-the-job training programs in sanitation practices. Other training programs are offered by the FDA and by trade associations such as American Institute for Baking, National Food Processors Association, and American Meat Institute.

A great deal of research is needed to improve food safety in the future. Advancements in current processing techniques and equipment are imperative if the industry is to provide high-quality and safe foods for tomorrow's consumer. A more basic understanding of the physical, chemical, biological, and nutritional properties of the foods and food ingredients, and of the changes that may take place due to various processing techniques are essential for proper design of equipment and processes to minimize undesirable changes.

In the Division of Foods and Nutrition at the University of Illinois, food additives are being used to help formulate low-sodium food products. Susan Brewer is investigating the use of sodium lactate, a flavor enhancer, to reduce sodium chloride content in and extend the shelf life of fresh and processed meat products. Terri Robertson, a doctoral student working with Barbara Klein, is studying the saltiness perception and interaction of sodium in aqueous gum solutions. Gums are added to food products as thickeners, stabilizers, and partial fat replacers.

Regulating Additives in Your Food

Responsibility for regulating food additives is given to FDA under the Food, Drug, and Cosmetic Act of 1938 and amendments in 1958 and 1960. The U.S. Department of Agriculture (USDA) also reviews additives proposed for use in meat and poultry products. Before any substance can be added to food, reasonable certainty that no harm will result from its allowed use must be established. The Delaney Clause, which is part of the 1958 Food Additive Amendment, prohibits the use of any food additive that induces cancer when ingested by humans or animals in any amount. Manufacturers are responsible for proving the safety of an additive and must petition FDA for approval. Food additives are continually reviewed for safety and, if necessary, may be withdrawn.

Before it sets usage guidelines, FDA considers the safety limits of the additive, the projected consumption of foods in which the additive will be used, and the least amount of additive needed to produce the desired function. Long-term and short-term toxicity studies must be conducted involving different species and successive generations of laboratory animals. The maximum quantity of the additive that can be used is set at one one-hundredth (or 1 percent) of the level at which there is no observed adverse effect in test animals. This precaution provides at least a 100-fold margin of safety.

Two groups of food additives are exempt from the testing and approval process. The first is prior-sanctioned substances that were approved for use by FDA or USDA before passage of the 1958 Food Additive Amendment. The second is additives classified as Generally Recognized as Safe because extensive past use has produced no harmful effects; for example, salt and sugar.

—Dawn Hentges, assistant professor of foods, Division of Foods and Nutrition

New technologies in the area of thermal processing need to be thoroughly studied. For example, aseptic packaging provides better-quality products with less exposure to heat, but it must be ensured that these products are adequately treated to provide absolute safety from pathogens. Microwave/irradiation technologies, which have been under investigation for more than half a century, are accepted in some countries but have yet to be successfully implemented on an industrial scale in the United States. However, these technologies hold potential for future improvements in the safety and quality of processed food.

The food industry is striving to meet the challenges of increasing world competition and the rising numbers of health- and safety-conscious consumers. Continued advancement in processing technologies and improved methods of safety analysis are critical to meeting the ever-growing consumer demands for high standards of excellence; continued microbiological, chemical, and nutritional safety; and the overall quality of our food supply.

J.G. Hawkes, visiting assistant professor, and W.E. Artz, associate professor, Department of Food Science

A Watchful Eye on the Food Supply

Prior to 1906, U.S. food-safety policy was laissez-faire and the food consumer beware. As people migrated from the farm to the city, the population changed from 80 percent farmers to the current 2 percent. The country was becoming dependent on suppliers of food, and there were no food-safety laws or regulation of these suppliers. The Pure Food and Drug Act of 1906 was a beginning. In 1931, the Food and Drug Administration (FDA) was subsequently created, and the 1938 Food, Drug, and Cosmetic Act required the presence of imitation flavor to be noted on labels, prohibited the manufacture or selling of adulterated or misbranded foods, and established standards of identity for certain foods (for example, all mayonnaise must consist of certain components in order to be identified as mayonnaise, but if it does meet the standard of identity, the components need not be listed on the product's label). This act also required the use of so-called Good Manufacturing Practices (GMPs) by food companies.

The U.S. Department of Agriculture (USDA) was given regulatory jurisdiction over meat and poultry products via Inspection and Wholesome Acts passed in 1906, 1967, and 1968. Currently, the USDA is also responsible for grade standards in meat and dairy products, fruits, vegetables, and grains.

World War II initiated a chemical revolution, and following the war, growers used pesticides extensively. The Miller Pesticide Amendment, enacted in 1954, established tolerances for pesticide levels in agricultural commodities based on safety testing. The Environmental Protection Agency (EPA) is responsible for enforcing these regulations.

A major regulatory policy was established in 1958 via the Food Additive Amendment to the Food, Drug, and Cosmetic Act. This amendment defined a food additive and established the term Generally Recognized As Safe (GRAS). Since 1969, all GRAS ingredients have been under review. One of the most significant components of this amendment was the Delaney Clause, which stated that no food additives would be allowed in the food supply if they were found to induce cancer in humans or animal. This clause, which the EPA must consider when it enforces regulations, established the "zero-tolerance" concept for carcinogens.

Policies established in the 1960s regulated color additives and packaging materials. The regulation of fish and shellfish grading and inspection is currently the responsibility of the Department of Commerce but will be delegated to the FDA and/or the USDA sometime in the near future. Alcoholic beverages are the responsibility of the Department of the Treasury's Bureau of Alcohol, Tobacco, and Firearms.

Current label regulations require that food be identified in bold type and contain the name and address of the manufacturer, packer, or distributor; the net quantity of contents; the net content of a serving; and all ingredients in descending order of content, except for those foods that have a standard of identity.

Between 1972 and 1990, certain nutritional information was also required if any nutritional claim or nutrient was added to the product. A totally revised nutritional labeling policy was put forth in the Nutritional Labeling and Education Act of 1990. The regulatory aspects have not been completed yet, but extensive information will be required on food labels, including previously exempt foods that have a standard of identity. This act also allows manufacturers to make certain health claims, provided that suitable evidence is available. Some products with the revised labels may be on the shelf by May 1994.

Current food-safety policy issues are genetically engineered foods; "natural" toxins in foods; substances in food ingredients that may have therapeutic or prophylactic activities against diseases, such as cancer and atherosclerosis; radiation of food products; and living with the Delaney Clause without jeopardizing the availability of the food supply.

—Art Siedler, professor of nutritional science, Department of Food Science

Food Safety in Your Home

Susan Brewer and Dawn Hentges

The health-conscious consumer looks for natural and minimally processed foods. Ironically, the microbes in fresh foods or in foods with limited barriers to microbe growth are a greater potential health hazard than the nutrients that are lost in cooking or than the chemical additives and pesticide residues that many people fear.

The United States and other industrialized countries are experiencing an unprecedented increase in foodborne illness. Each year, between 10 million and 24 million people in the United States suffer from salmonellosis, staphylococcal food poisoning, botulism, *Clostridium perfringens* poisoning, and trichinosis. If unreported, untreated, or misdiagnosed cases are added, the number of people affected may exceed 80 million. One-third of these cases can be traced to food mishandled at home.

Illness that originates in home-cooked food is obviously a problem. However, most cases are relatively mild and of short duration, and even the most serious case can be prevented by following good food manufacturing and handling practices. The scientific community is also an aid: From time to time, we discover a new microbiological hazard (for example, *Campylobacter jejuni, Yersinia enterocolitica,* and *Listeria monocytogenes*). These agents may explain some of the outbreaks whose causes were not identified in the past.

Causes of Foodborne Illness

The four factors that contribute most often to outbreaks of foodborne illness are:

- Holding food at the wrong temperature, including inadequate cooling
- Inadequate cooking
- Using contaminated equipment when handling food
- Poor personal hygiene by the food handler

The microorganisms that cause foodborne illness grow by increasing in number rather than size. Unlike spoilage microorganisms, these pathogens may not produce any off-odors, off-flavors, or discoloration. The bacteria *Staphylococcus aureus* and *Clostridium botulinum* produce their effects through toxic metabolites resulting from bacterial growth in the food before it is eaten; foodborne illness of this type is referred to as food poisoning or food intoxication. Other pathogens such as *Salmonella* produce illness through ingestion of living organisms; foodborne illness of this type is referred to as a food infection. Some illnesses are caused by a combination of the two: *Clostridium perfringens* grow to high levels in the food, form spores in the digestive tract, and release a toxin that causes illness as the spore is released from the cell. Agents of foodborne illness may be introduced at the farm, during food processing, or during food preparation, typically when food is held before and after it is served.

The severity of microbial effects ranges from temporary discomfort to acute toxicity to death. The time required for the onset of symptoms depends on the way in which the organism causes illness. Organisms that produce toxins in the food before it is consumed generally cause symptoms earlier than organisms that must be ingested live and grow in the system. Symptoms of staphylococcal food intoxication generally occur one to six hours after the food is ingested, whereas salmonellosis symptoms occur 12 to 18 hours after ingestion. The most common symptoms of foodborne illness are diarrhea and abdominal discomfort.

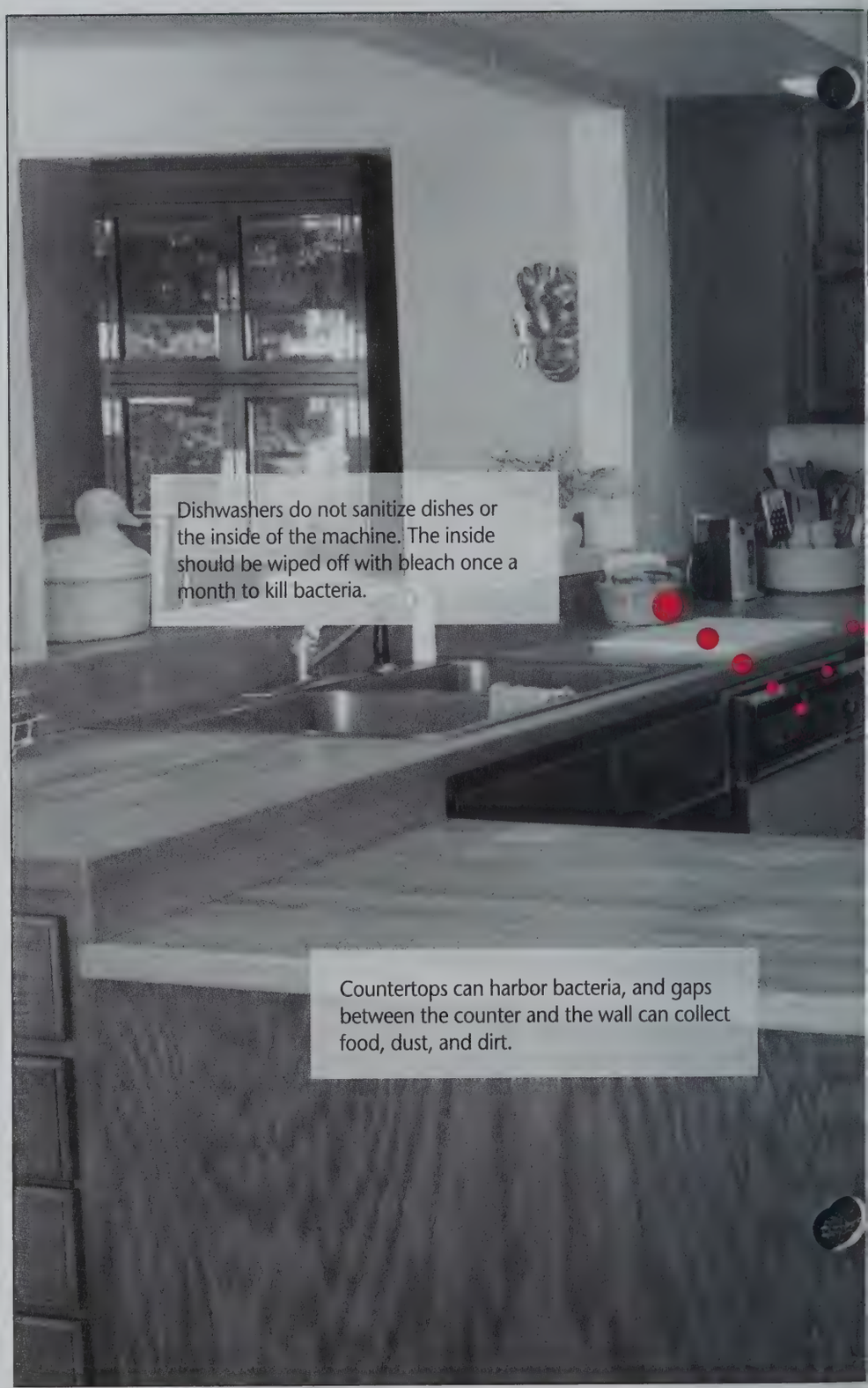
Foods can serve as vehicles for many pathogenic and toxigenic agents of disease, including bacteria, viruses, molds, and parasites. The most common bacterial foodborne illnesses result from *Staphylococcus aureus, Clostridium perfringens, Salmonella* species, *Bacillus cereus,* and *Clostridium botulinum.* An assortment of viruses can become foodborne and

pose a potential hazard to the consumer. The virus responsible for infectious hepatitis is one such agent. Many molds can produce toxic organic compounds during their growth on foods and feeds. The mycotoxins that they produce can cause food intoxications of various sorts. Parasites that are significant in transmission of foodborne illnesses are usually associated with foods of animal origin, including pork and wild game.

For bacteria to cause foodborne illness, they must:

- Find a food that meets their nutritional requirements.
- Find a food environment that is neither too acidic nor too basic. This sort of environment is found in milk, some meats, casseroles, soups, egg products, and many grain products.
- Have time to adjust to a new environment. If bacteria are transferred from hands into potato salad, it will take approximately two hours for the bacteria to adjust to their new environment and start growing. After that, they can double in number every 20 to 30 minutes. In a very short time, the levels in the food can be high enough to cause illness.
- Find a temperature that is optimum for their growth. Most bacteria prefer to grow in the 45° to 140°F range. This temperature is often referred to as the danger zone.
- Have oxygen in order to grow. But some of the most problematic microbes will grow or even prefer to grow without oxygen.
- Have moisture or water so they can ingest food. Dry foods are much less likely to cause a foodborne illness.

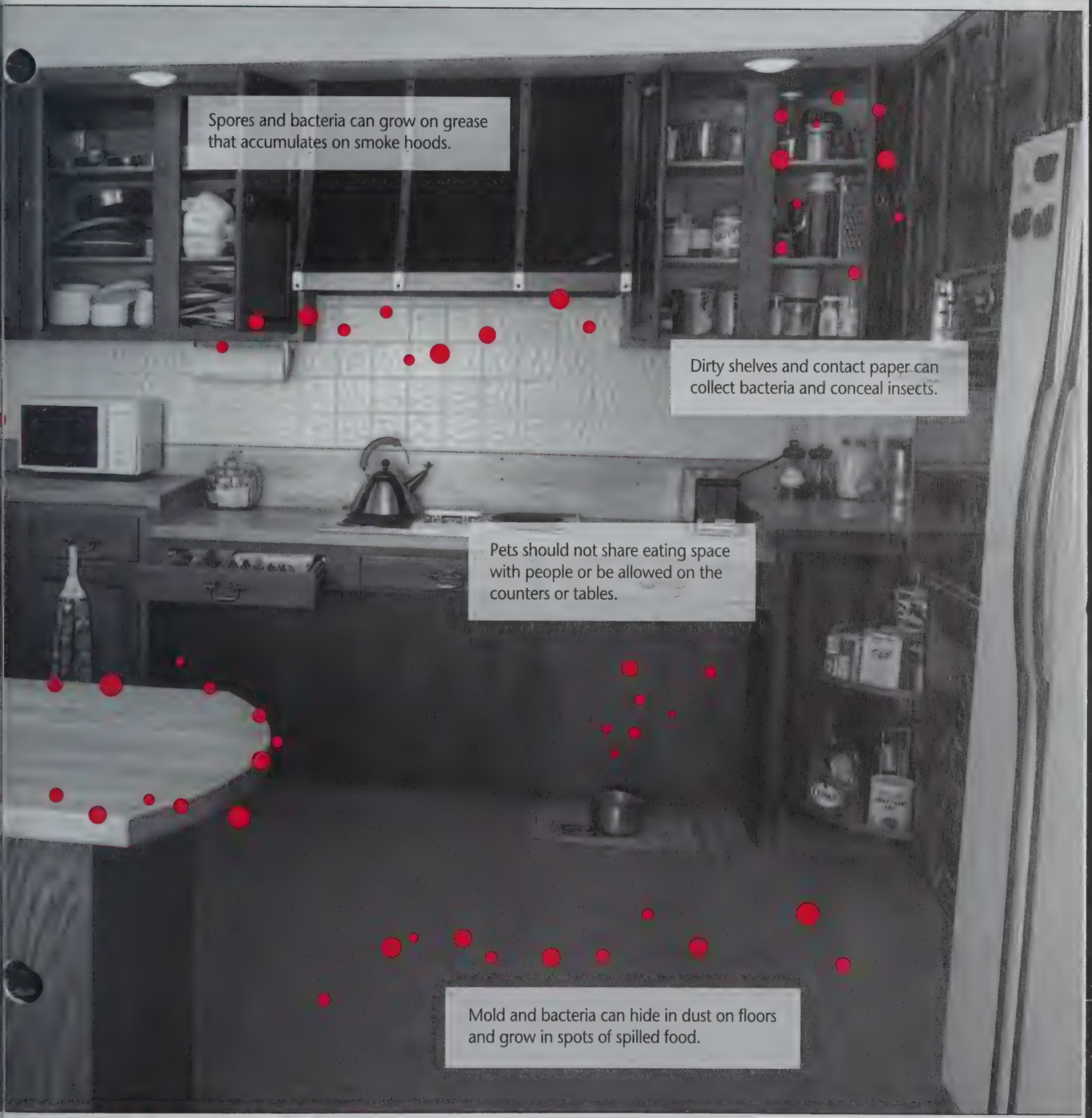
Although foodborne illness receives a great deal of press coverage at times (for example, when a major outbreak is traced to a restaurant), many people are ignorant of the conditions in their own homes that can lead to illness. In a 1992 survey of 400 Illinois consumers, Susan Brewer of the Foods and Nutrition Division at the University of Illinois found that 74 percent of the respondents thought that storing food in an open can



Dishwashers do not sanitize dishes or the inside of the machine. The inside should be wiped off with bleach once a month to kill bacteria.

Countertops can harbor bacteria, and gaps between the counter and the wall can collect food, dust, and dirt.

In addition to cleaning the obvious areas, food safety in the kitchen must also include less prominent spots.



Top 10 Tips for Trouble-free Dining

The following are the top 10 considerations for preventing foodborne illness in the home:

1. ***Clean hands.*** Food preparers should wash hands and fingernails thoroughly before handling and preparing food, after using the toilet, and every time hands are soiled.

2. ***Clean utensils.*** Dish detergent, hot water, and chlorine bleach will sanitize utensils. Cutting boards used for raw meats and poultry and blenders must be carefully cleaned and sanitized after each use.

3. ***Clean food.*** Food can be infected by coughs, sneezes, handling, dirty equipment, vermin, animals, and wastes. Food should be protected during storage, preparation, display, and service.

4. ***Correct temperature to keep foods.*** Food is safest immediately after it is prepared. The longer it is held, hot or cold, the greater the chance that it will become a safety hazard. Dry foods (bread, granola, crackers) and foods "preserved" with sugar, salt, or vinegar are stable at room temperature.

5. ***Correct temperature to store foods.*** Perishable foods should be chilled in shallow containers and stored in the refrigerator or freezer. When defrosting foods, foods should be thawed in the refrigerator or microwave oven and cooked immediately.

6. ***Thorough cooking.*** Most pathogenic microorganisms are killed during adequate cooking. The risk of foodborne illness is greater from consuming raw meat, poultry, seafood, and eggs.

7. ***Healthy food preparers.*** Diseases may be passed to other people in food. Germs from infected wounds may cause food poisoning. People with open wounds, sore throats, diarrhea, and eye or ear infections should not handle foods. All workers should wear clean clothing, including aprons or smocks, closed leather shoes (no sandals or canvas tennis shoes), and a hairnet or a bandana to restrain hair.

8. ***Safe foods.*** Dry and high-sugar foods are almost always safe. Examples are breads and rolls; cakes (without cream filling); fresh fruits and vegetables; cookies and crackers; candies; dried foods such as granola, raisins, and jerky; and properly home-canned jams, jellies, and pickles.

9. ***Potentially hazardous foods.*** All foods of animal origin and cooked starch foods are potentially hazardous. Extreme caution should be taken with items that contain any amount of foods in these categories.

10. ***Problematic foods.*** Cooked fruits and vegetables and processed meats belong in this category. Foods deserving extra caution include cooked vegetables; fruit salads; green salads; lunch meats and hot dogs; cheeses; and home-canned, high-acid foods.

—Susan Brewer and Dawn Hentges, Division of Foods and Nutrition

would cause the food to become poisonous. Sixty percent thought home-canned beans were always safe to consume as long as the lid was sealed, 48 percent thought it was safe to completely cool foods to room temperature before refrigerating them, 30 percent thought that scraping mold off food prior to eating it was a safe practice, and 25 percent thought that soup left at room temperature overnight was safe to eat if it was boiled for five minutes.

On the other hand, 96 percent of the respondents knew that unsafe foods may not be identifiable by smell or appearance and that food from bulging cans should not be used, 93 percent knew that meat and poultry should never be thawed at room temperature, 91 percent knew that poultry should be stuffed just prior to cooking, and 91 percent knew that cracked eggs should be discarded. These results show that food-safety education programs have been successful in some areas, particularly in the handling of raw or frozen foods of animal origin. However, home food-handling of leftover cooked foods and canned or preserved foods remains an area in which consumers can benefit from food-safety education.

Susan Brewer, assistant professor of foods, and Dawn Hentges, assistant professor of foods, Division of Foods and Nutrition

Safety Starts at the Farm

Richard Isaacson

Public concern about foodborne illness increased recently when an outbreak of food poisoning killed four children in the northwest United States. The outbreak occurred when hamburger contaminated with a type of *Escherichia coli, E. coli* O157:H7, was improperly cooked and served at restaurants in a fast-food chain. This incident demonstrates the problems that can occur when contaminated meats, milk, or eggs are eaten by unsuspecting persons. It also underscores the need to develop techniques that will prevent preharvest (on-farm) contamination of animals by foodborne pathogens.

The American public perceives that outbreaks of foodborne illness in this country are increasing. Actually, the likelihood of contracting a foodborne illness in the United States remains low. It is true that an estimated 1.5 billion cases of foodborne illness worldwide result in 3 million deaths annually, but many of these deaths occur in countries with poor sanitation and little refrigeration of food. Changes in the way animals are raised and an increased worldwide demand for these food products account for some of the increase. Better reporting practices and better diagnostic procedures to identify foodborne illnesses have also contributed to public concern. Although the number of outbreaks in the United States remains low, foodborne illness is a serious problem, and we need to develop methods that will reduce the risks. To do this will require a better understanding of the mechanics of foodborne disease.

Which little piggy should go to market, and which little piggy should stay home?

According to the Centers for Disease Control, the foodborne bacterial pathogens most often reported to be active are *Campylobacter, Salmonella,* and *E. coli* O157:H7. All three pathogens cause diarrheal diseases. *Campylobacter* is frequently associated with bloody diarrhea (particularly in children), abdominal pain, and fever, while *Salmonella* is associated with self-limiting, watery diarrhea. In severe cases, however, *Salmonella* can spread throughout the body of the infected person, causing life-threatening septicemia. This is particularly likely in geriatric populations—such as in nursing homes—where deaths due to *Salmonella* are not uncommon. *E. coli* O157:H7, a recently discovered foodborne pathogen that is increasing in incidence, is associated with bloody diarrhea, severe abdominal pain, and, occasionally, anemia due to damage in the kidneys. In children and the elderly, this disease can be life-threatening. All three pathogens are usually spread by consumption of contaminated foods, although cases attributed to direct contact with carrier animals or person-to-person contact have been documented.

These pathogenic organisms can be introduced into products of animal origin on the farm, at the packing plant, or during preparation of processed food. Researchers have not determined how the organisms are introduced into the food chain. *Salmonella* can be introduced

into animals early in life, making them lifelong carriers of the pathogen. For example, pigs inoculated three to four weeks after birth remain infected 28 weeks later when they are ready for slaughter. Other animals, including calves, lambs, chickens, and turkeys, can also be *Salmonella* carriers. Recently, chicken eggs contaminated with a specific serotype of *Salmonella, S. enteritidis,* have been found. The problem has most frequently originated in flocks in the eastern United States, but extensive distribution has resulted in the shipment of contaminated eggs to other locations. The U.S. Department of Agriculture (USDA) therefore recommends that all shell eggs be cooked properly before they are eaten and that only pasteurized eggs be consumed raw. Scientists believe that animals are also the carriers of the other important foodborne pathogens. *E. coli* O157:H7, for example, has also been identified in cattle.

Most animals infected with foodborne pathogens remain clinically healthy. Visually, they do not appear to be different from noninfected animals, making inspection difficult. In some cases, infected animals can be identified by culturing their blood, feces, or other samples. For example, pigs that were challenged experimentally with *S. typhimurium* continued to shed the pathogen in their feces for at least 24 weeks. Unfortunately, in natural settings, this does not always happen. As a result, blood or fecal samples of known carrier pigs frequently do not contain *Salmonella*. *Salmonella* can hide in specific tissues, and, when the pathogen is in these sites, it cannot be easily detected. Simple serum antibody tests are not conclusive because the pathogen concentration in animals is apparently not great enough to consistently trigger an immune response.

These difficulties in identifying carrier animals cause obvious problems when animals reach the packing plant. Because carrier animals cannot be identified by routine visual inspection of carcasses, contaminated and uncontaminated animals are kept together. Ideally, of course, carrier animals would be eliminated from the processing line and prevented from coming into contact with noncarriers.

One of the consequences of processing contaminated carcasses side by side with noncontaminated carcasses is the increased likelihood that products from both animals will be contaminated. In the processing plant, clean surfaces become contaminated by direct contact with the carriers. When uncontaminated products come in contact with the contaminated surfaces, they also become contaminated. A second problem arises when meat products are processed. Because ground meat products may be prepared from several animals, it only takes one carrier to contaminate the entire product.

Animal products may also become contaminated during transportation to the packing plant. Many bacterial pathogens replicate more rapidly in animals that are physiologically stressed. Because animals are likely to become stressed during transportation, organisms that are hiding may grow. Growth causes increased shedding of the pathogen, generally in feces; the pathogen can then spread to other animals in the transport vehicle or in holding pens at the packing plant.

Preventing an Identity Crisis: New Animal-Tracking Technology

A miniature transponder being tested at the University of Illinois may soon make it possible to trace a carcass from a packing plant where it is being processed to the farm where the animal was fed several weeks or months beforehand. The device, which can be injected under the skin at birth or attached in some other way to the animal, will provide lifetime identification.

Providing this information may become mandatory if legislation proposed in USDA's pathogen reduction program is enacted. USDA officials believe that a national system of identification would help locate livestock producers who are chronic chemical residue offenders—especially with antibiotics; such a system would also identify farms where livestock are infected with dangerous pathogens. The ability to provide this information should boost consumer confidence in the safety of the U.S. meat supply.

Livestock producers have dreamed of such a system since the dairy industry began using neck-mounted transponders to automate delivery of feed about 15 years ago. Two years ago, University of Illinois scientists implanted 50 transponders into baby calves and 50 more into yearling heifers. The yearling heifers have now freshened and are identified automatically each time they pass through the milking parlor. The trial has proven the durability of the units and confirmed that they will operate after injection for long periods of time.

Now that implanted electronic identifiers are on the brink of moving out of the laboratory onto the farm, scientists are working to make sure the new technology is safe. In an effort to make sure that the new transponders cannot be passed on to consumers in the meat, researchers have encased the transponder in an ear tag and designed the tag so that it cannot be reused on another animal. The ear tag model has been used since March 1993 with excellent results. All units are still operating, and they are read automatically as cows pass through the milking parlor, just as the injected transponders are.

Although a national identification system would add to production costs, it would also provide important benefits to live-

If effective management practices are employed at the preharvest level, microbial contamination is less likely to occur. Unfortunately, research on effective on-farm strategies is lacking. Logic dictates that sanitizing housing facilities and ensuring that animals do not consume contaminated feed or water would reduce the introduction of pathogens into the food chain. This view, however, does not take the ecology of the pathogenic organisms into account. It is not known how these organisms actually infect animals, and most of the information on this process is anecdotal. When scientists understand how the infection process works, they will be able to devise strategies to reduce or eliminate the contaminants.

The USDA formed a regional committee to study these questions in 1992. Committee NCR 176 is composed of participants from the land-grant universities, primarily from the north-central states, and includes representatives from the University of Illinois. The committee will attempt to learn the ways in which foodborne pathogens are transferred to animals and the mechanisms that bacteria use to infect and maintain persistent populations in these animals. With this information, methods may be developed to detect foodborne contaminants on the farm and at the processing plant. Researchers should then be able to intervene at critical junctures in livestock production to reduce or eliminate the contaminants.

The Food Animal Production Consortium, administered through the University of Illinois, has also taken an active role in preharvest food safety. The consortium is composed of scientists from Kansas State University, Michigan State University, the University of California at Davis, the University of Florida, the University of Illinois, and the University of Nebraska. In November 1992, the Consortium convened an international workshop to address ways in which the safety of food of animal origin could be increased around the world. The workshop made two important recommendations. The first was that a National Advisory Council on food safety be established that would make recommendations on voluntary quality assurance programs, research priorities, control programs, and educational programs. The second recommendation was the development of research programs to learn how the organisms enter the food chain and the development of methods to reduce the spread of disease by on-farm intervention.

If the incidence of foodborne illness is to be reduced, aggressive research programs to learn how to identify the pathogens in carrier animals are critical. The key to success will be the development of simple, sensitive, and rapid detection assays that can be used with the animals on-farm. Ultimately, food safety depends on a successful partnership between the livestock producer, the packer and processor, and the consumer or food-service worker responsible for its final preparation. Each group has a responsibility to ensure the safety of the final food product.

Richard Isaacson, associate professor of microbiology and immunology, Department of Veterinary Pathobiology

stock producers. An electronic link to slaughter and packing plants could bring important carcass trait information back to breeders. This information could be used to accelerate current trends toward leaner, faster-growing animals. Electronic implants may also replace heat branding as a permanent method of identification in the beef industry, a change that would please animal welfare activists and increase the value of the hide for the producer.

The United States has long been a leader in controlling communicable diseases in livestock, and our livestock population is relatively free of most diseases that can be passed on to humans. The incidence of chemical residues in meat is quite low, but tracing affected animals has been difficult. USDA would also like to be able to find the source of specific strains of bacteria that may not cause illness in animals but can cause illness in humans when they are passed from one to the other. Plans for international standardization of an animal identification system are also under way. When this occurs, it should be possible to trace a problem anywhere in the meat supply back to its source and correct it.

—Sidney L. Spahr, professor of animal sciences, Department of Animal Sciences

The yellow ear tag contains a miniature electronic identification device. The unit replaces the chain and tag typically worn around the animal's neck.

Pesticides in Our Food: Scientists Respond to Consumer Concerns

Lisa Sheppard

Pesticide use has always had its supporters and its detractors, and the debate over food safety and pesticide residues is currently heating up. The Clinton Administration made a commitment to reduce pesticide use in the United States last June when a report was released questioning the safety of pesticide residues in food, particularly for children.

The outcome of the debate in Washington is being felt closer to home.

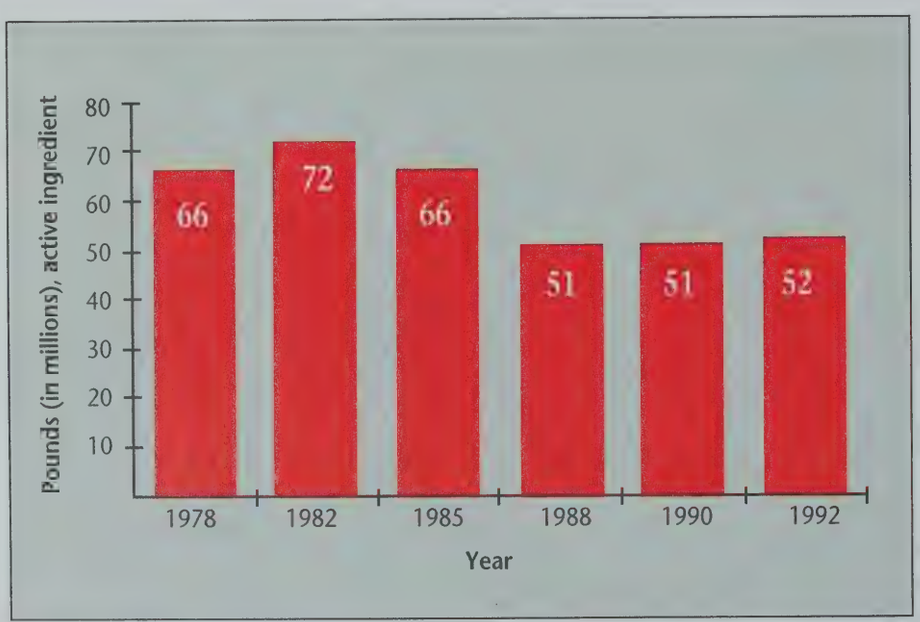
"If policy makers chose to reduce even by half the legal tolerance levels of pesticide residues in food as a way to reduce exposures, the safety of foods would not necessarily improve and Illinois agriculture would be affected very little," says Rick Weinzierl, a University of Illinois entomologist. The reason is that actual pesticide residues on food crops, as determined by the current monitoring systems, are on average well below government standards for safety.

"On the other hand," Weinzierl continues, "if regulations prohibit any residues of specific pesticides in foods or eliminate uses of particular pesticides, then producers and the ag industry as a whole would be forced to look more closely at alternatives."

The use of pesticides in agriculture helps to maintain the high quality of foods that consumers expect and to provide an abundant food supply. The big question is: Would consumers accept blemished fruits and vegetables and greater evidence of insect and disease damage? In a few cases, consumers have filed lawsuits against food manufacturing companies after finding insects in canned foods.

"Consumers generally don't seem any more enamored with insects than they are with insecticides," says Weinzierl. "If standards for insect damage or contamination become more lenient, we can certainly reduce pesticide use."

Total Pesticide Use on Row Crops in Illinois, 1978–92



Researching the Alternatives

For decades, researchers at the University of Illinois have studied the questions raised during the ongoing debate on pesticide safety. How can producers reduce the use of pesticides? What are the alternatives?

Now, as the "sustainable agriculture" movement gains momentum, farmers are responding to consumer concerns about pesticide use and food safety. For the past two years, approximately 70 producers have been conducting on-farm research into alternative agricultural approaches as part of the UI's Participatory On-Farm Research Program. The experiments test various components of sustainable agriculture.

Although the term is difficult to define, the State of Illinois Sustainable Agriculture Committee says that an agricultural system is sustainable if it is based on the prudent use of renewable and/or recyclable resources; it protects the integrity of natural systems so that natural resources are continually regenerated; it improves the quality of life of individuals and communities; it is profitable; and it is guided by a land ethic that considers the long-term good of all members of the land community.

About a dozen UI scientists and Extension personnel work with the on-farm researchers to "help farmers fine-tune their use of pesticides and tailor [their] use to things like soil types, environmental conditions, and the individuals' farming practices," says Dick Warner, assistant director for natural resources and environment in the UI Agricultural Experiment Station.

"One real trigger for all of this work," he says, "has been the reduced use of pesticides. Some producers in the program have completely walked away from pesticides; others are trying to use pesticides at a very low rate.

"A UI researcher personally sits down with producers and helps them set up experiments to make sure they are valid, helps to carry those studies out, and even helps to analyze the data," Warner continues.

Some examples of questions that these on-farm experiments have attempted to answer are:

- Can I cut my herbicide rate in half and still control weeds? Will reducing broadleaf herbicide in corn still give weed control that is comparable to the full rate?
- How does an "organic" product compare with an insecticide on second-year corn?
- What is the lowest economical rate of herbicide that we can use on our farm?
- Can mechanical weed control be as effective as combined chemical and mechanical weed control in soybeans in a ridge-till system?

Warner wants to share the results of the experiments with agricultural producers.

"We have regional tours that don't just draw from our core group of 70," he says. "Many people come who aren't currently using sustainable agriculture but are interested."

Warner is also excited about the exchange of information between UI researchers and participating farmers. With the advent of producer participation in on-farm experiments, the sharing of information becomes a two-way street.

"There is an interplay between traditional research farms and participatory, on-farm research," he says, "and they share an interest in the reduced use of pesticides. We may apply the information from participatory, on-farm research to our UI research farms."

University scientists who are doing research on campus are working on the same questions in a different environment. The question, however, remains the same: How can producers minimize the risk of pesticides and still grow a product consumers will want to buy?

UI agronomists studying pesticide use have learned that pesticides are an essential part of pest control practices in Illinois. In fact, 98 percent of Illinois farmers use pesticides, according to David Pike, a University of Illinois agronomist. Nevertheless, a 1990 survey of statewide pesticide use indicated that although the percentage of corn acreage treated with herbicides remains quite high, many farmers are using herbicides at lower rates. This decrease in actual use is attributed to new herbicides that are effective at lower concentrations and to producers who lower herbicide rates to fit their needs.

"Farmers are searching for herbicides that will do more, are easier to use, and are safer for the chemical applicator and for the crop," says Pike. "If they find a new herbicide that is considered to be safer, they will frequently use it, even if it costs more than other products. Farmers are concerned about pesticides and how they affect health, no doubt about that."

How can producers minimize the risk of pesticides and still grow a product consumers will want to buy?

Adjusting rates of some herbicides by giving greater attention to such factors as temperature, humidity, weed species, soil moisture, size of weeds, and growing conditions could add greater precision to herbicide use and possibly reduce the amount being used. Most farmers now tend to use "rule-of-thumb" guidelines indicated by the labels for determining the amount of herbicides needed for their fields, according to Ellery Knake, a UI weed scientist who is studying ways to reduce herbicide use.

"As much weed pressure as we have out there, we hesitate to cut herbicide rates too much," Knake says. "However, as more sophisticated techniques are developed, we can expect greater precision. Using optimum amounts can benefit both grower and consumer."

In the future, farmers may use chemical applicators that detect and spray weeds that are present in a field. But for now, Knake recommends using scouting practices to identify problem areas and specific weed species for planning the attack.

Although herbicides have been quite effective for controlling weeds, farmers can use other practices in a complementary manner. Planting crops in narrow rows to provide a canopy that will shade growing weeds can help. Shading weeds from the sunlight will suppress weed growth somewhat. UI research has shown that the plant canopy must provide at least 95 percent shade to control giant foxtail, a common weed in Illinois cornfields.

The rotary hoe and row cultivator can also be used to control weeds. The hoe is

similar to a garden rake in that it disturbs the soil and uproots weeds.

Knake is also studying the practice of planting "filter" strips of perennial grasses around water sources to reduce the amount of herbicides, especially the commonly used product atrazine, that leach into the groundwater and surface water.

For government set-aside acres, farmers often opt to plant cover crops, such as oats, wheat, and clover. Once a good cover crop is well established, it can help to control weeds.

Most farmers use a comprehensive weed control plan that includes both chemical and nonchemical control methods, says Knake.

Although insecticide use is not as widespread as herbicide use, effective insect control is still crucial, particularly for food crops, says Weinzierl. He and his colleagues at the UI Office of Agricultural Entomology have been studying alternative controls: using predators, parasites, and pathogens to control insect pests that cause the most damage.

Given current consumer standards of quality for produce, however, biological controls rarely provide all the answers.

Consumer Options

Like producers, consumers too have options when they are concerned about pesticides.

Community farming is becoming more popular, according to John Masiunas, a UI horticulturist who is researching vegetable-crop farming systems using re-

Healthy Agricultural Ecosystems Mean a Safer Food Supply

Human populations will face many challenges in the 21st century because previous generations neglected the underlying causes of problems they were trying to solve. They also failed to anticipate and counteract complications arising from the solutions they imposed. Major problems have arisen from their unwillingness to consider the entire agricultural ecosystem in which they were trying to effect change; as a result, today's agricultural community suffers from a diminished quality of life. And some of the current problems in food safety can be traced directly to the shortcomings of previous solutions.

Despite increased sales of agricultural commodities to expanding human populations, farm families are often experiencing economic failure, environmental deterioration, and social deprivation. Many families have partially depleted their soils, depleted or contaminated their groundwater, killed the fish in their streams, deprived terrestrial and aquatic wildlife of habitat, and watched their communities wither with no end in sight. Our narrow focus in solving problems has sustained relatively few producers.

A more promising approach to problem solving involves considering problems in the context of their ecosystems. In this approach, ecosystems are defined by borders, whether of a private property, township, county, town, city, state, nation, watershed, or other region. Ecosystems have identifiable human stewards and inputs and outputs, such as energy, air, water, plants, animals, people, chemicals, and other products and byproducts. The ecosystem's resources are finite, and we are going to have to simultaneously conserve and exploit them for a very long time. Thus, to keep the ecosystem healthy, we must identify its stewards and develop interdisciplinary strategies for problem solving. At the same time, we must reassess our effectiveness and refine our methods more consistently.

In natural, healthy ecosystems, there are high levels of organization. For example, within and among species, you see both competition and interdependency. There are also high levels of productivity (for example, biomass production), and especially, there is the capacity for self-repair despite stress. Healthy ecosystems, for example, can adjust and compensate for severe weather or a change in the health status of a single species.

Biological diversity is critical because it increases the ecosystem's ability to utilize resources as conditions change over space and time. As in medicine, threats to ecosystem health are addressed most efficiently through prevention. When a threat to a healthy ecosystem is

duced pesticides. Consumers purchase a share of the farm and supply some of the labor. In this way, they can be assured that produce is free of pesticides. "Organically grown" fruits and vegetables—products grown without the use of pesticides—are also available in local stores.

"Consumers who are concerned about the safety of pesticide residues in foods should be aware that the best-looking produce is not necessarily what they'll want to buy," Masiunas says. "The blemish-free tomato likely comes from a field that has been treated with a variety of chemical pesticides."

As consumers and producers await Washington's proposals on pesticide use, Masiunas does not recommend curbing produce in the diet to limit pesticide residues.

"It is decidedly more harmful from a nutrition standpoint to eliminate fruits and vegetables in the diet than to risk any health effects consumers might have from pesticide residues," he says.

Precisely because these foods are so important to our health, university scientists have made the minimizing of risks from pesticides a high priority in their research. As they lend their expertise to producers who are concerned enough to experiment with them in reducing pesticide use, consumer confidence in the safety of our food supply will continue to grow.

Lisa Sheppard, Extension communications specialist, Office of Agricultural Communications and Education

identified early on, research can be conducted into underlying causes, and different methods of solving the problem can be attempted and evaluated.

An agricultural ecosystem is an ecosystem that has been purposefully altered to include people, plants, and animals on production sites. But the boundaries extend to take in the surrounding landscape, including nearby villages and towns. A healthy agricultural ecosystem might include farms that produce wholesome foods, enough profit to stimulate vibrant communities, increased soil depth and quality, clean groundwater and surface waters, and, on sites that are not in production, habitats that are capable of supporting abundant and diverse populations of wildlife. The different components of the ecosystem (human, domestic animal, wildlife, plant, economic, and the social health of the community) require the involvement of many interacting specialists. Many of today's problems are a product of incentive structures mandated in current agricultural policies. To choose more rational policies, we must advocate the preservation of the resource base more strongly. We must also educate the public and their government representatives about methods of production that will increase the health of the agricultural ecosystem.

The healthier the agricultural ecosystem, the safer our food supply will be. Nature teaches us that wider spacing of food-producing animals enhances food safety. Studies have shown that less concentrated livestock production systems decrease the incidence of diseases in animals, including those diseases that are transmissible to humans via foods of animal origin. Such systems can reduce the need for drugs, which can also contaminate the food supply, and the systems can lessen runoff of animal wastes. Greater crop diversity can reduce not only the need for fertilizers but also insect predation and the need for pesticides. Moreover, as producers increase the diversity of their products, agricultural enterprises should become more economically vital and resilient over time.

—Val Beasley, veterinary toxicologist, Department of Veterinary Biosciences

This landscape illustrates the relationship between a hayfield, pond, and forest.

UI Research Includes Functional Foods for Health

Vitamins. Proteins. Fats. Carbohydrates. We've heard about them all our lives. Now scientists are using new words to describe a new approach to what we eat. So-called nutraceuticals, bioreactive foods, and phytochemicals are not necessarily nutrients, but these naturally occurring chemicals or food components may prevent or cure diseases.

Researchers want to determine more precisely which foods and ingredients (alone and in combination) offer significant preventive properties and then develop foods with enhanced levels of those substances. Referred to as designer foods, functional foods, or nutraceuticals (a combination of nutrition and pharmaceutical), the results are ordinary foods with naturally occurring components that may prevent or cure disease. (See the article "New Weapon in the War Against Chronic Disease" in the Spring/Summer 1993 issue of *Illinois Research* for a more complete discussion of phytochemicals and their powers.)

The Functional Foods for Health program at the University of Illinois is a joint program between the Urbana-Champaign campus and the Chicago campus. The program focuses on how nonnutritive dietary components affect health. The program is under the direction of Clare M. Hasler, who holds appointments in the Department of Food Science at UIUC and in Nutrition and Medical Dietetics and in Medicinal Chemistry and Pharmacognosy at UIC.

Clare M. Hasler directs an interdisciplinary program to discover how nonnutritive dietary components affect health.

The program combines expertise from agriculture and medicine with knowledge from other disciplines to examine how naturally occurring components in foods may protect humans from disease and how these components can be modified in food systems. Each campus offers a unique contribution. The land-grant campus in Urbana-Champaign provides talent in developing value-added products; the medical center campus in Chicago contributes experience in studying health-care interventions.

Current projects involve approximately 55 faculty from six colleges and 12 departments. Research goals include identifying and measuring bioreactive food compounds; assessing human health-promoting properties; developing methods to enhance compounds in raw and processed foods; and defining technical issues that influence Food and Drug Administration regulations and health claim evaluations.

"We're interested in developing an industrial affiliates program," Hasler says. "We want to provide contract research and collaborative opportunities with companies in the pharmaceutical and food industries. Our goal is to be self-supporting with outside funding by the fall of 1995." *—Richard C. Bogren, media/communications specialist, Office of Agricultural Communications and Education*

Honors for Magazine Staff

Illinois Research magazine recently earned top honors at the annual Agricultural Communicators in Education (ACE) international conference in Miami. The magazine was selected for first place among four-color periodicals. Awards were made to ACE members Nancy Nichols and Anita Povich, editors, and Tina Prow, science writer. Prow also received a third-place award for her story about entrepreneurship that appeared in the Fall 1992 issue, which focused on "Revitalizing Rural Illinois."

Riding the Wave to Seafood Safety

In response to consumer demand for increased safety and quality of seafood, the UI Cooperative Extension Service is offering a new training program for retail seafood handlers. This program will teach handlers the correct methods necessary to provide high-quality and safe seafood to the public.

In association with the Illinois-Indiana Sea Grant Program, Southern Illinois University at Carbondale, and the Illinois Department of Agriculture, CES will offer several low-cost, one-day workshops that combine lectures and hands-on skill-building exercises. Participants can take what they learn back to their establishments and train other seafood handlers in their stores.

Many topics will be covered, including harvesting methods; seafood safety (with a focus on sanitation, foodborne illness, and inspection); species identification (including discussion on economic fraud by species substitution); and quality assurance (with specific guidance on handling and storage and specifications for obtaining high-quality fish from suppliers).

Participants in the CES training program will receive a good introduction to the Hazard Analysis and Critical Control Points (HACCP) system, which was created to identify potential risks to food safety and prevent their occurrence. The U.S. seafood industry and various regulatory agencies are working together to adopt the HACCP procedures. When the HACCP system becomes an industry regulation, retail seafood handlers who have taken the CES training program will better understand what they must do to comply.

For more information on the training program, contact Dawn Hentges, Extension Specialist, Foods and Nutrition, University of Illinois, 351 Bevier Hall, 905 S. Goodwin, Urbana, IL 61801.
—Robin Goettel, communications coordinator, Illinois-Indiana Sea Grant Program

College of Agriculture Open House

Despite a record 10.2-inch snowfall, these children traveled from McDade School in Chicago to attend this year's College of Agriculture Open House. Here, they are participating in a chocolate-chip taste test conducted by 4-H'ers from the Space Age Pioneer Club of Chenoa, Illinois. The 1993 event drew 16,000 visitors even with the snow, and this year we're hoping for better weather.

The 1994 Open House will be held February 25 and 26 from 9 a.m. to 4 p.m. each day. It will include 130 demonstrations and displays planned to support this year's theme, "Get Down to Earth." Highlights will include a space suit, an Illinois time capsule, animals, gardens, high-tech exhibits, and free ice cream.

The University of Illinois Stock Pavilion, 1402 West Pennsylvania, will be the headquarters for the event, but exhibits will be housed in nine different buildings. This year, the National Soybean Research Lab will open its doors to visitors. Admission to all buildings is free. Open House is a great opportunity to get acquainted with all the research that's being done in the College, so try to get there if the roads are clear.

University of Illinois at Urbana-Champaign
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Cyril B. Hopkins, c. 1915. Known as the "great prophet of modern agriculture" for his work in soil fertility, Professor Hopkins was one of the first agricultural researchers sent on an overseas aid mission. The scientist and vice director of the UI Agricultural Experiment Station was decorated by the king of Greece after World War I for his work with Greek soil reclamation.

In the next issue:

Returns on Investments in Agricultural Research

A look at the social, environmental, and economic impacts of agricultural research in the past, present, and future...

- *Agricultural milestones at the University of Illinois*
- *Prospective payoffs of current research*
- *New communication methods, better access to information*
- *Then and now: A photo essay*
- *New faces in the College of Agriculture*

Illinois Research

Agricultural Experiment Station
Winter 1993/94

Returns on Investments in Research

"Daddy and Me" program promotes happy families

College of Agriculture, University of Illinois at Urbana-Champaign, Volume 35, Number 1

The Cover

Brent McBride, in background, is director of the Child Development Laboratory and assistant professor of human development and family studies. Pictured with him are Alexandra Kelly and her father, Kevin, who participate in a model parenting program known as "Daddy and Me." See story on page 4.

Illinois Research

Winter 1993/94
Volume 35, Number 4

Published quarterly by the University of Illinois Agricultural Experiment Station

To receive a free subscription to *Illinois Research*, Illinois residents may write to the Editor, *Illinois Research*, Information Services, OACE, 47 Mumford Hall, 1301 West Gregory Drive, Urbana, IL 61801. Telephone: (217)333-4780. For bulk orders, write to the above address or call (217)333-2007.

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Returns on Investments in Research

Research Pays in Many Ways

The Illinois Agricultural Experiment Station is the research arm of the University of Illinois College of Agriculture. We deal with the basic things of life — the provision of food, clothing, and shelter, and the well-being of people, families, and communities. We look for ways to

- Advance technologies to expand markets for agricultural products and employment in the agricultural and food sector in Illinois
- Promote the economic development and management of agricultural and food systems and rural communities in Illinois
- Increase the capacity of crop and animal systems to respond to changing world food demands
- Improve nutrition, food quality, and human health
- Provide for sustainable use of natural resources

About seven hundred people work for the Illinois Agricultural Experiment Station. These include scientists and other professionals, graduate students, technicians, and clerical workers. In the fiscal year ending September 30, 1994, the Station will expend about $40 million conducting agricultural research. Roughly half of this amount will come from regularly appropriated funds from the state and federal governments. The citizens of Illinois and other states will pay these amounts as part of their taxes. The other half of this support will come in the form of grants, contracts, gifts, and sales of products and services from research operations.

To obtain support, we must demonstrate to state and federal legislators, agency administrators, and private sector managers that an investment in our operations will have a high return. When we request support, we are, in effect, asking for venture capital. Often our ventures are joint ventures, launched in cooperation with other institutions, agencies, and private firms.

The Agricultural Experiment Station has many clients and customers, each with somewhat different needs. Our customers include

- Consumers of agricultural products and services
- Producers, processors, distributors, and retailers of agricultural products and services
- The vast supporting infrastructure of agriculture (including rural communities, financial institutions, suppliers, builders, transporters, agricultural and trade organizations, consultants, branches of government, media, and other institutions of higher education)
- People with environmental concerns

The question is, Are we living up to the expectations of these many customers and clients? Does our work justify the investment of public and private funds?

One way to find the answers to these questions is to look at our track record. That is what we attempt to do in this issue of *Illinois Research*. Much of the issue is devoted to "anecdotal" evidence, that is, stories of specific research efforts and the benefits they generated. While these are interesting and reveal a rich history of dedicated effort and valuable contribution, they do not tell the whole story.

Most of the economic benefits of publicly supported agricultural research come in the form of small, incremental improvements in agricultural productivity and in the quality, safety, affordability, and convenience of food products and services. These benefits are modest for any one individual in any one year, but aggregated over all consumers and all the people who work in the industry of agriculture and over a period of years, they are enormous.

Some researchers, both inside and outside the public agricultural research establishment, focus on measuring these aggregate benefits. When this research began back in the 1950s, researchers tried to estimate the benefits of specific new technologies, such as hybrid corn, and attributed those benefits to the research leading to the new technology. Now, economists attempt to measure societal benefits from public research, private research and development, public extension, and farmers' schooling.

Through these studies, economists are able to measure both producer and consumer "returns to research" and can determine who is helped and who is hurt by new agricultural technology. They are able to measure costs and benefits for individual crops and classes of livestock and for individual states. They can also identify situations in which research

The Experiment Station's clients and customers are a diverse group, ranging from people concerned about the environment to traditional agricultural producers.

benefits are likely to "spill over" to other states, regions, and nations as well as other situations with few spillover benefits. Although there is still some disagreement on the interpretation of some of the findings of these researchers, there is considerable agreement on the overall effects of agricultural research.

So what is the bottom line? U.S. agriculture has experienced a century of uninterrupted growth in productivity — a really remarkable record. The output of U.S. agriculture is about five and a half times what it was a century ago, while the real value of inputs only increased 15 percent over that period. According to agricultural economists W.E. Huffman and R.E. Evenson, the average annual, pre-tax return on the public's investment in the whole package of agricultural research between 1951 and 1982 was 41 percent, an extremely high return by any measure.

As the techniques for measuring returns on investments in research improve, agricultural economists are incorporating information on the off-site and other indirect economic and social effects of agricultural technology. This provides a more accurate estimate of the distribution of the costs and benefits of various technologies.

Studies of the returns from agricultural research are valuable to all decision makers who influence agricultural research. The studies help identify research areas with the greatest likelihood of payoff. They also reveal the important roles not only of research but also of extension and human capital development in agriculture. They identify situations for which the linkages between research and practical outcomes need improvement. They reveal areas of research best conducted by private firms and those best conducted by public institutions and agencies.

Often the research and development leading to improvements in agriculture involve several institutions and private firms, so we cannot claim all the credit. We are part of a unique system of public and private agricultural research. We like to think that we are a very important part of the system, but it is the system that should get the credit.

Likewise, the past record is not reason for complacency. Agriculture is changing rapidly, in part due to agricultural research. It continues to face great challenges. The Illinois Agricultural Experiment Station must change also. It must improve, both in the way it organizes research and in the way it conducts research. We continue to work on that improvement. — *Don Holt, director, Agricultural Experiment Station, and Sarahelen Thompson, interim assistant director of AES and associate professor of agricultural economics*

Farewell Ivory Tower: Innovative Research Has Practical Results

Tina M. Prow and Sarahelen Thompson

If you think professors and scientists rattle around the ivory tower talking only to each other and thinking big thoughts that have little relevance to the real world, consider the researcher whose parenting studies prompted him to develop a program that helps fathers become more involved with their children. Or the entomologists whose on-farm research helps farmers understand when not to use insecticides.

Consider that the findings of agricultural economists in the areas of lending practices, risk, and financial management are applied almost as quickly as data are analyzed. Or that an animal scientist who developed a better swine and broiler nutrition plan receives invitations from all over the world to explain how the diet reduces production costs and pollution.

Consider that fruits and vegetables, already known to be good for you, can be even better when researchers improve the nutritive content. Scientists also are studying disease-prevention qualities in foods that may help reduce risk from cancer, cholesterol, and other diseases.

These projects are a small sampling of research conducted at the University of Illinois College of Agriculture. The College's historic land-grant mission of research, teaching, and extension attracts faculty with a broad range of interests and a strong sense of purpose. For these scientists, the College's laboratories serve as staging areas for research that leads to innovative products, practices, and thinking that challenge convention, revolutionize industries, drive change, and ultimately benefit society. Many scientists also teach, bringing to the classroom the latest developments in a field — often developments from their own laboratories.

Daddy Can Do It

Seeing research put to use as quickly as the data are analyzed is something Brent McBride has experienced since he started studying family relationships in the late 1980s. In fact, he considers parallel development of basic and applied research to be a goal.

"Everything I do has a purpose of: what does it mean to the real world; what does it mean to families struggling for redefinition of roles; what does it mean for people in the child development field," he says.

In the 1990s, he notes, parents increasingly are faced with changing expectations for what men and women do in the family. For instance, the message that fathers should be more involved with their children is everywhere in advertisements, television, movies, and magazines. Yet McBride's research with parents who record activities in time-use diaries shows the parenting workload is almost unchanged.

"If fathers are doing anything different, they're playing more with their kids, but all the functional work that relates to the kids still is done primarily by mothers," he says.

That is not to say that fathers are unwilling to do more, he adds, saying fathers often volunteer that they do not know how to do more. That admission prompted McBride to develop an applied research project aimed at fathers. "There are a lot of messages saying do something different, but not a lot of information on how to do it. As a society, what I suggest we do is create mechanisms that help men make changes and increase parenting options for families."

The "mechanism" McBride created is a model parenting program, called "Daddy and Me," for fathers of preschoolers. His partner in the project is his wife, Rebecca McBride. An assistant dean for academic programs in the College of Agriculture, she participates not as part of her position but because "the work is rewarding." The McBrides' goal is to sensitize fathers to ways they can be more active participants in parenting. Each Saturday for 10 weeks, the fathers spend time in supervised, interactive play with their children. Then they meet with other fathers and a facilitator to discuss issues they identify as important to their roles as fathers.

The participating fathers often come from different age, economic, cultural, and social backgrounds. Even so, as a group and individually they generally report less stress related to their parenting role after going through the program, McBride says.

"We actually see changes in parenting," he says. "These fathers play with their children, but they also start taking on more of the responsibilities that are time-consuming and emotionally draining and don't necessarily involve direct contact with the kids."

The parenting research is a natural

Four-year-old Jamie Rhoads of Champaign shows her father, Bruce, the fine art of painting. The father and daughter are part of a model parenting program offered by the Child Development Laboratory.

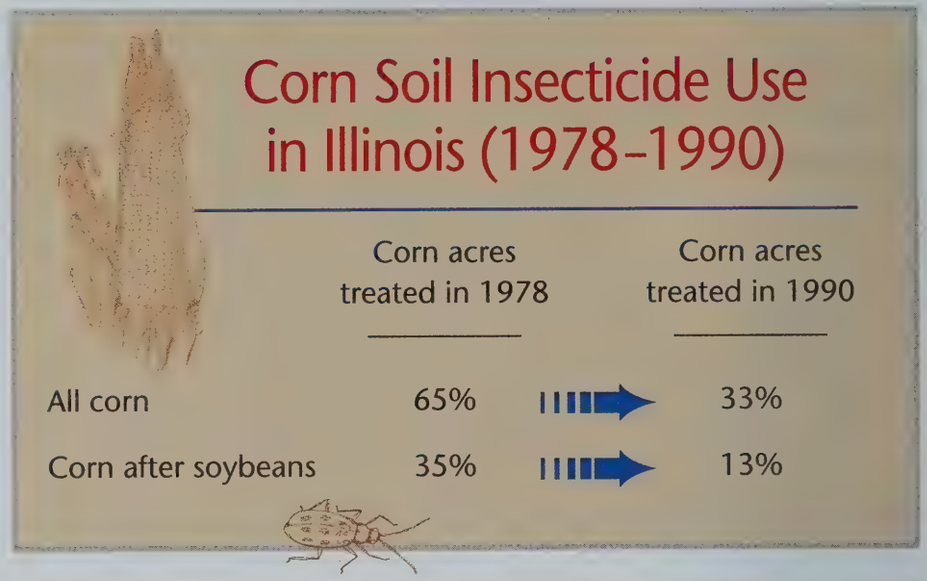
spinoff from the UIUC Child Development Laboratory that McBride oversees. A model program for early child care, the laboratory is "not only a good place for children," he says, "but also reflects the College's mission of teaching, research, and service." Students from many colleges on campus come to the laboratory to observe. Some put classroom theory into practice through work-study projects. Faculty and graduate students worked on twenty-five research projects at the laboratory last year.

Genuinely dedicated to child and family welfare, laboratory teachers contribute to the College's three-part mission by assuming a leadership role in the community. They participate in parenting and teacher workshops, serve on child-care advisory boards, and write for newsletters and magazines aimed at teachers.

When Farmers Are Bugged

The intricate weave of teaching, research, and extension forms a strong backdrop for the College's integrated pest management program (IPM). Developed in the 1970s to promote favorable economic and ecological outcomes from pest management, IPM is grounded in crop rotation, planting and harvesting schedules, pest-resistant varieties, natural enemies, pest monitoring, projected damage thresholds, and other strategies that minimize pesticide use. The strategies are developed and tested by scientists around the country, including entomologists at the UIUC. Research data from their studies provide Illinois Cooperative Extension Service specialists with a scientific base of information to help producers and crop consultants keep up with rapid changes in pest management recommendations.

One measure of the effectiveness of that research is the reduction in corn acres treated with soil insecticides. Fifteen years ago, Illinois farmers applied soil insecticides to 65 percent of the corn acres to protect against such pests as corn rootworm and black cutworm. Recent surveys show the number of treated acres has dropped to about 33 percent.



Instead of soil insecticides, many farmers rely on a soybean crop to interrupt the life cycles of pests that feed primarily on corn. "The research showed clearly that soil insecticides are not necessary on corn following soybeans," says Kevin Steffey, a UIUC Extension entomologist.

Without UIUC research in the late 1980s, the numbers might have gone the other way, adds colleague Michael Gray. Interest in soil insecticides was heightened when researchers found a small percent of northern corn rootworm hibernated through two winters rather than one. The finding meant farmers relying on crop rotation for rootworm control might have more damage than usual, but did the damage warrant applying soil insecticides? UIUC researchers found out by going into 1,100 first-year cornfields and measuring rootworm damage. Their reports of low rootworm populations and little damage averted a potential shift to higher soil insecticide use, Gray says.

The number of acres treated each year with soil insecticides might drop even further as word spreads of a recent on-farm study of soil insecticide rates. Twenty-nine farmers reduced soil insecticide rates applied to continuous-corn fields without experiencing greater corn rootworm injury. In fact, Gray says, data show rootworm levels in most fields were not high enough to cause economic damage.

"We went into this reduced-rate study specifically to look at how effectively farmers could use lower rates to achieve root protection," he says. "What we ended up finding out was that most producers aren't needing soil insecticides to begin with. Most don't have economic infestations."

In addition to on-farm research, farmers and others interested in pest management work with UIUC entomologists to monitor several pests. For instance, hundreds of people around the state monitor black cutworm moth flights into Illinois each spring. This allows entomologists Steffey and Gray to project a date that populations likely to cut corn plants will strike. The "early warning system" has contributed to a drop in at-planting applications of soil insecticides for black cutworms.

The benefits from reducing soil insecticide applications in corn are significant, particularly in northern Illinois where about 90 percent of the continuous corn is treated each year, Gray says. "It saves money from a production standpoint, and it reduces the total pesticide load in the environment."

Success of the Illinois IPM program is due in part to the close and constant contact Steffey, Gray, and their colleagues maintain with producers and crop consultants. The entomologists oversee one of the country's premier on-farm research programs involving farmers. Unique to the UIUC IPM pro-

gram is a team of IPM Extension educators located off campus to help producers around the state identify and solve pest problems. In addition, the UIUC entomologists coordinate a newsletter, annual conference, workshops, and short courses for producers and crop consultants.

"We use our research to support our Extension programs and use our Extension programs to get feedback for research," Steffey says. "We want to make sure that all our programs are aimed to benefit the farms economically but also to benefit society at large so that society doesn't have to pay for mistakes."

Of Barns and Banks

Growing a crop or raising livestock can mean long hours in the barn — and the bank. Long before the planter comes out or the feed order is placed, most farmers visit lenders for land, production, and other loans.

A decade ago, many of these farmers used a balance sheet only if their lender required it, and few understood how they were evaluated. Furthermore, the evaluation factors lenders used were unreliable for some cases. Today, however, farmers and lenders are more financially astute, in part due to UIUC research in farm financial management. Findings from a number of studies have allowed farmers to seek and obtain better financing and lenders to assess risk more accurately.

Peter Barry and David Lins are among a nationally recognized UIUC faculty working to improve the quality of information between borrowers and lenders by analyzing borrowing, lending, and investment practices of farmers and farm lenders. Their work is supported in part by the Center for Farm and Rural Business Finance, a cooperative effort of the UIUC and University of Arkansas. The center sponsors research in all areas of finance and credit affecting farmers and rural businesses. Although primarily focused on the agricultural finance system, their research findings also have application for consumer banking.

"If we can improve the system efficiency, everybody's better off," Barry says. "As you get better information developed, better networking of how procedures to evaluate creditworthiness work and their uniformities, then that lowers the cost of farmers' borrowing. The effect is a combination of either lower interest rates or greater credit availability, or more suitable returns on borrowed money that make it easier to repay — easier in the sense of lower risk for lenders and a better overall system."

One focus of Barry's research is on how capital is made available to Illinois farmers. That includes studying the way lenders go about evaluating creditworthiness of farmers. Recent studies show a new trend toward letting interest rates adjust to the level of risk. According to Barry, this trend is a recognition of differences in creditworthiness among farmers: higher-risk farmers should pay higher interest rates to help compensate the lender for higher repayment risk.

With this shift in lending practices, how lenders evaluate creditworthiness becomes more important and makes Barry's research on credit-scoring systems particularly relevant. His findings show a high degree of similarity among lenders but differences in their use of terminology.

"The research shows more uniformity in the way creditworthiness is being evaluated than you might expect by just looking at the instruments and talking to the lenders," Barry says. "The implication is that farmers should shop around some. The terms will not be that different, but there's enough difference between the interest rates and the non–interest rate terms that farmers need to listen to what several lenders say to put it all together to make the right choice."

Helping farmers and lenders understand financial choices is an interest of Lins. During the farm financial crisis of the 1980s, he counseled farmers and lenders with research-based information to help them improve their financial management skills. His research at that time provided the Illinois Farm Development Authority with the data it needed to call for changes in a proposed loan guarantee program, a move that helped save the state an estimated $15 million in potential loan losses.

In the area of farm financial management, Lins is causing some lenders to rethink financial performance measures. Using UIUC Farm Business–Farm Management records, he has shown that an accrual measure of income is a better measure of profitability than a cash measure of income. Research data show a 60 percent to 80 percent discrepancy between the two measures, meaning farmers and lenders who make decisions based on cash basis information could have an 80 percent error in their measure of income, Lins says.

Lins also is challenging conventional thinking with his investment analysis research. Like many of his projects, this research resulted from questions posed by farmers and businesses. The research shows that farmland currently is a good investment for those with cash but a poor investment for anyone borrowing money to pay for it. Whether or not farmland is a good investment at any point in time depends largely on the returns to land ownership, the returns on other investment opportunities, and the cost of borrowed money. In today's economic environment, he suggests, farmers might be better off investing in machinery and livestock and renting rather than buying land.

"The perception is that you're always better off if you own land than rent land," he says. "But if you look at returns to ownership of land today, you can expect about 6 percent of market value from cash rent, and inflation will be another 2 to 4 percent, so you're at a return of around 8 to 10 percent. Take off 1 percent for taxes and you're back down to 7 to 9 percent return to the ownership of land. Now, if you borrow money to buy that land, you'll pay 7 to 9 percent to borrow that money.

"So if you've got cash to invest in farmland, it's a good deal compared to nonfarm investments like certificates of deposit. But to borrow money to buy land doesn't make a lot of economic sense."

Lins's research into rent versus pur-

chase of land has become a cornerstone of classroom discussion on investments. This link between research and teaching in all areas of agricultural finance contributes to a strong academic program at the UIUC. *Farm Futures* magazine ranked it "the best place to study ag finance" in its survey of agricultural colleges in the nation ("The Best Education," mid-March 1993).

Making sense of complex financial information is the impetus behind another one of Lins's projects — a spreadsheet-based model for evaluating refinancing of home and farm mortgages. A generic model with fewer limitations than any program currently available, it could work with almost any property being refinanced, he says. The new spreadsheet will be available through Extension when work is completed.

Ideal Diet Improves Performance, Reduces Pollution

Another new, practical tool that far surpasses anything already in use is the Illinois Ideal Protein Diet for swine and broilers developed by David Baker. This diet, the UIUC animal scientist suggests, is "revolutionizing how animal feeds are put together" because it can lead to more efficient gains, cheaper meat, and reduced pollution from animal production. Although aimed at swine and poultry, the ideal protein ratio is causing pet-food manufacturers to rethink formulations and prompting calls from scientists working in human nutrition.

Baker's research and development of the ideal protein diet is built on studies conducted in the 1950s at the UIUC by H.H. Mitchell, H.M. Scott, and other pioneers in nutrition research. They identified many of the amino acids — the building blocks of protein — necessary to form muscle. That early research had little relevance to Illinois producers, who used corn and soybeans for a near-perfect amino acid pattern, but it was used in Great Britain to develop what became a world-accepted standard for figuring amino acid requirements from alternative feeds. In 1986, however, Baker began to suspect that the standard was flawed. In particular, some of the amino acid recommendations looked too high, he says.

With genetically leaner pigs coming to Illinois, the availability of cheap synthetic lysine and other amino acids, and increasing concern about animal pollution, Baker decided it was time to revisit the early UIUC research, evaluate the accepted standard, and, if necessary, develop a better diet. He spent two years working with a chemically defined diet that served as a tool for developing an "ideal" pattern of amino acids for pigs and broilers — a pattern that met the animals' amino acid requirements without the excesses responsible for pollution.

The pattern he developed had lower levels of nutritional components compared to the standard, but pigs and broilers performed better on it. Now known as the Illinois Ideal Protein Diet, the pattern defines the requirement for lysine, an essential amino acid often short in swine diets, and then lists all other amino acid requirements as a percentage of lysine. Consequently, producers need to know only the lysine requirement to figure the amino acid ratios for any diet.

Because new genetic lines of pigs are leaner and more complicated to feed using traditional approaches, the ideal protein diet is a timely development, Baker notes. Body compositional factors and dietary factors that affect individual amino acid requirements have no effect on the diet ratios.

Another benefit to improved performance is the reduced nitrogen and phosphorus pollution in excreta of animals fed using the ideal protein diet ratios, Baker adds. Recognizing pollution from animal production as a threat to fish and groundwater quality, several European countries already have laws regulating nitrogen and phosphorus in animal waste.

"You could say that we've been working for 25 years to come up with these desired ratios; it's very basic, fundamental research," Baker says. "In the last four years, we decided to make it practical, and now our pig ratios are being used to formulate feeds through commercial channels throughout the world. It's an example of how you can take fundamental knowledge and use it in the practical setting."

If calls, letters, and invitations to speak on the Illinois Ideal Protein Diet for swine and poultry and its potential for cat and dog diets are any indication, animal diets will change dramatically over the coming decade, Baker says.

Food as a Prescription

Could foods be an integral part of the prescription for good health? Some UIUC researchers think foods known to be good for you could be made better, like the sweet corn that UIUC horticulturist Jack Juvik is studying with a goal to reduce calories and improve nutritive value. Juvik is one of more than fifty faculty members working with Functional Foods for Health, a joint program of the UIUC and UI at Chicago. These researchers are looking at foods that may have benefits for preventing disease and promoting health.

The belief that foods have health benefits is not new. For instance, the Europeans and Japanese have long maintained that certain berries have cardio-protection and anti-tumor properties. UIUC horticulturist Mary Ann Smith is studying the wild blueberry and bilberry, lingonberry, and cranberry to find a basis for that belief. She is identifying phytochemicals, naturally occurring secondary products in plants.

Her goal is to reproduce the phytochemicals in tissue cultures and then find ways to change the phytochemical content in cells. If the phytochemicals prove to have health benefits and Smith's tissue culture strategies are successful, one possible result from this research might be pharmaceutical production of extracts with the health-promoting phytochemicals. That could make berry production an alternative crop in Illinois. Or breeders might develop varieties with more of certain phytochemicals.

How the amount of phytochemicals in plants might affect health is an interest of UIUC horticulturist Robert

It's a bird, it's a plane, it's Supermuffin! Well, not exactly. But nutritionist Sue Potter (pictured) is convinced that incorporating soy protein into our everyday diets could improve our health. The trick, according to colleague Barbara Klein, is to develop soy foods that are tasty enough to get people to change their diets.

Skirvin. He is looking at the different amounts of phytochemicals in onions, blackberries, and strawberries. Eventually he will collaborate with UI-Chicago human-health researchers to assess different levels of phytochemicals for chemo-cancer prevention.

How much of a good thing is enough is also a concern of UIUC nutritionist Susan Potter. She is studying the effects of soy protein isolate on cholesterol levels. The first series of studies, conducted at the Veterans Affairs Medical Center in Danville, Illinois, showed blood cholesterol levels for twenty-five male patients eating soy-fortified foods dropped an average 11 percent.

That drop in cholesterol levels, accomplished with 50 grams of soy protein, moved some patients from high-risk to moderate-risk categories, consequently reducing their risk for cardiovascular disease. In a follow-up study conducted outside the hospital environment and using lower soy protein levels (25 grams), cholesterol levels again dropped in subjects with high cholesterol levels. A new study will focus on effects of soy protein in women, including effects of estrogen-like compounds found in soy.

That soy protein reduces cholesterol is not a new finding, but the way Potter is studying the effect makes the finding more relevant than ever. Most early soy studies put subjects on diets that replaced all the animal protein with soy or used liquid formulations unlikely to be maintained by most individuals over a long period. But Potter's approach is to look at a typical U.S. diet and determine where soy might easily and acceptably be added every day — and that is in baked goods. To formulate recipes for baked goods that taste good even though they have soy protein, she is relying on Barbara Klein, a UIUC food scientist. Klein is using soybean protein isolate in breads, muffins, and other baked goods and also developing a quick-mix for breads. The soy protein is virtually undetectable in these baked goods.

The soy protein isolate used in Potter's studies is not commercially available, so it may be some time before Americans find soy-fortified breads and muffins on store shelves. But the company that eventually picks up the challenge to commercialize soy-fortified foods will likely find a market, Potter predicts.

"In a cafeteria study a couple of years ago, we offered soy bread and soy muffins, but people didn't really buy them. Yet when we put out educational cards, sales went up dramatically," she says. "People are interested when they are informed."

Tina M. Prow, science writer, Agricultural Experiment Station, and Sarahelen Thompson, interim assistant director of AES and associate professor of agricultural economics

Ag College Recruits All-Stars for Winning Team

Anita Povich and Tina M. Prow

Although you won't find them performing to a crowd of cheering fans, the four scientists profiled here are in a league of their own. They are key players on the College of Agriculture's winning research team, which includes hundreds of scientists supported by a $40-million annual research budget.

Each featured researcher is a prospect whose career bears watching. Their impressive stats include numerous publications, awards, fellowships, multimillion-dollar research grants, and recognitions for innovation and creativity. ***Sharon Donovan****, a former National Institutes of Health fellow, was recently honored as a Future Leader in Nutrition from the International Life Sciences Institute, which gives only three awards a year. A top acquisition last year from his post as director of the Center for Wildlife Ecology at the Illinois Natural History Survey,* ***Richard Warner*** *is a seasoned veteran who blazed a trail in interdisciplinary environmental studies. A former high-school basketball coach,* ***Neal Shay*** *now uses his winning ways to coach graduate students in human metabolism. He joined the Illinois team after a two-year postdoc at Florida's Institute for Food and Agricultural Sciences.* ***William Sullivan*** *is an innovator in landscape design, environmental planning, and plant–people interactions. His high-energy approach and cooperation with other universities have caught the eye of major funding groups such as the U.S. Environmental Protection Agency.*

No stranger to playing fields across the country, these researchers have gone to bat with the best at Stanford, the University of Florida, UC-Davis, the University of Massachusetts, the University of Michigan, Kansas State, Iowa State, and in Urbana-Champaign with the UIUC home team.

These all-stars go well beyond the traditional view of a scientist in a white lab coat with test tubes and a microscope for company. They're in tune with real-world issues and are collaborating with grad students, postdocs, and colleagues to help solve complex societal problems.

What makes them outstanding? Their love of scientific discovery, dedication to the task at hand, and ability to work through frustration and disappointment — all part of the research game.

Sharon Donovan was finishing up undergraduate preveterinary studies when a physiological chemistry course excited her about nutrition. A lecture on maternal and infant nutrition cinched a change in career paths. She followed up with postdoctoral research on a National Institutes of Health (NIH) fellowship at Stanford University School of Medicine, where she studied growth hormones with the pediatric endocrinology faculty.

Her graduate research focused on human milk and its advantages over formulas for premature babies. Formulas approach human milk in nutritional aspects, and most infants thrive on formulas, but formulas do not provide the same bioactive components as human milk, she says. These components play a protective role for at least the first 10 years of life.

The San Jose, California, native continued that research when she came to the University of Illinois at Urbana-Champaign in 1991. Donovan teaches two to three classes each year, and her research is gaining national recognition. She received a Future Leader in Nutrition award from the International Life Sciences Institute and recently collaborated on an invited ar-

ticle on growth factors in milk for *Annual Reviews in Nutrition.*

Her research interest remains focused on human milk, formula nutrition, and premature infants. One method she is using to conduct research is a piglet model developed in collaboration with UIUC animal scientists. The piglet digestive tract is similar to that of humans, so researchers can simulate the effects of such problems as premature birth, compromised nutritional support, and intestinal injury.

Among the projects Donovan finds most exciting are:

- **Insulin-like growth factors (IGF).** Found in human milk, IGFs stimulate growth. To find out how much, researchers measure and trace effects of IGF on growth, intestinal development, and enzyme digestive levels using the piglet model. Now in the second year of a four-year NIH grant, Donovan's team hopes eventually to develop formula products with IGF for premature infants.

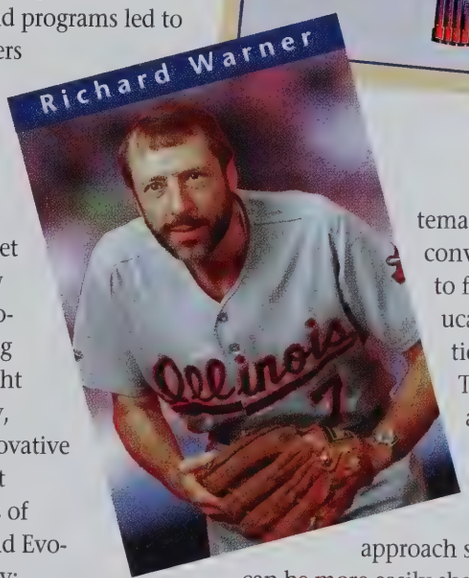
"It may take a decade, but our goal is to develop a product to help infants," Donovan says. "If we can show the function in piglets, we can do future studies in infants, especially premature infants. They are compromised to begin with — very often they need surgery or have other problems — and human milk is a definite advantage."

- **Hormone therapy during recovery from malnutrition.** Malnutrition is the primary cause of child mortality worldwide and can cause permanent growth stunting. Research has shown that growth hormone and insulin-like growth factor therapy combined with nutrition can normalize growth. These studies may have future applications in developing countries, according to Donovan.
- **Curriculum for teenage mothers.** Still in developmental stages, this program will promote breast-feeding to teen mothers.

"I have a basic science background and interest, but applied science interests as well. I've always worked with women and children," Donovan says.

Richard Warner developed an appreciation and respect for nature while gowing up in the Fox River Valley in northern Illinois. His father was an outdoorsman, and many of his hometown friends around Elgin, were farmers. Although he flirted with the idea of marine biology, his desire to stay in the Midwest drew him back to agriculture and the environment. He interned at the Illinois Natural History Survey in 1970, enrolled in a master's program in 1973, and went on to pursue a doctoral degree while working with the Survey.

Warner's interest in agricultural environment, policies, and programs led to a focus on how farmers perceive such issues as water quality or use of energy and other finite resources. He also explored how farmers get information and how they are influenced toward change. Ignoring warnings that he might hurt his marketability, Warner chose an innovative doctoral program that spanned departments of Ecology, Ethology, and Evolution; Rural Sociology; Agricultural Education; and Education.



"I noticed that ecological research and conservation programs ignored the ag setting and related to pristine, pure, highly theoretical programs or the undisturbed environment — did such environments really exist? Now it's trendy to be involved in disturbed environments and study the effects of humanity," he says.

Last October, Warner joined the Illinois Agricultural Experiment Station on a part-time basis to foster growth in involvement and integration in natural-resources research, teaching, and outreach programs of the College of Agriculture.

"I'm doing what I want to do," Warner says of his unusual career path. "I'm one of those lucky people."

High on Warner's list of goals is to develop an accurate, broad-based systematic approach for conveying knowledge to farmers through education, communication, and influence. That entails linking agencies, private groups, faculty, and researchers in a team or systems approach so that knowledge can be more easily shared.

For instance, understanding the way that farmers relate to agriculture, agencies, and farm programs opens avenues for solving some environmental problems. The set-aside program is an example of missed opportunity for societal gains, Warner suggests. It diverts land only for a short-term reduction in crop production, when it potentially could include incentives to protect soil and water and enhance wildlife habitat. Wetlands policy is an example of how farm programs can adversely affect conservation. Farmers once received incentives to drain wetlands; now that wetlands are recognized as nature's filters and home to many wildlife species, however, landowners must be educated to protect wetlands.

"Farm programs can have multiple benefits to society: they can benefit nat-

WARNER

Associate professor, Department of Forestry; interim assistant director, Agricultural Experiment Station; and College's Agro-Ecology Program coordinator

Education:

- B.S. in fish and wildlife biology, Iowa State University
- M.S. in ecology and Ph.D. in interdisciplinary environmental studies, University of Illinois at Urbana-Champaign

Working philosophy:
The environment is a stress point for agriculture. We want the Agro-Ecology Program to help agriculture address environmental issues and make good decisions that will benefit farmers and society for the long run.

Illinois All-Stars

ural resources, so society benefits; they can improve recreational opportunities; and they can reduce nonpoint-source pollution that society pays for," he says. "We need to be asking up front what the outcomes of farm programs should be and at the start involve agencies that will deliver those outcomes. We have to spell out which farm program practices are benefiting society and why.

"It's not a matter of dollars; society invests millions of dollars in set-aside and gets little in benefits. It's more a matter of the conservation community developing effective ways to communicate what their needs are; it's a matter of developing ways for conservationists and the ag community to work together."

Warner plans for the UIUC Agro-Ecology Program to take leadership roles in several projects intended ultimately to help the conservation and agricultural communities work together. Among them:

- **Information systems.** This proposed project will describe how agriculture has changed and look at information in a new way using new computer tools and science. It will involve communications experts, home economists, agricultural economists, farm families, and others. The ultimate goal is to provide opportunities for farmers to learn about and envision the effects of adopting various farming practices relative to a range of factors pertaining to the sustainability of agriculture. These socioeconomic factors include net profits, time management, farm landscapes, and natural resources.
- **Water quality.** A new farm on the south edge of campus may be used to study the headwaters of the upper Embarras River. Teams will take a systems approach to look at farming systems at the river head.
- **Farming systems.** On lands given to the University of Illinois for research and interests in agro-ecology, teams will take a farming-systems approach that emphasizes environment, sound practices, and sustainability over the long term.

Neil Shay was fascinated with math and science as a youth in Fairfield, Connecticut. After receiving his master's degree, that fascination kept him in the classroom for six years, teaching high-school biology and physics and coaching basketball and other sports. But curiosity enticed him back to graduate school, where his interest in math, science, and the human body drew him to genetics and molecular biology. Today Shay teaches and conducts research in nutritional molecular biochemistry — how body cells are affected by nutrition.

He came to the University of Illinois at Urbana-Champaign in 1993, having finished postdoctoral studies in the Department of Food Science and Human Nutrition, Institute for Food and Agricultural Sciences, University of Florida. There, a National Institutes of Health fellowship allowed him to focus on nutrition and zinc deficiency. Zinc, a part of more than two hundred different proteins or enzymes at work in the body, affects growth, appetite, and the immune system. Far from being a narrow niche, his interest in zinc has allowed him to study problems ranging from human anorexia to livestock weight gains.

"Even in America, infants and older folks may be marginally zinc deficient," he says. "We're looking at specific tissues or functions that are altered by zinc and at the brain and appetite regulation."

At the UIUC, Shay teaches a human metabolism class to students interested in food and nutritional sciences. He also is developing agricultural seminar courses to help students learn about appetite control systems and the nutritional regulation of genes.

In addition, Shay is continuing his research on the effects of nutrition on gene regulation. Among the ongoing studies:

- **Zinc deficiency.** One goal is to identify specific biochemical and molecular sites that are critically affected by zinc deficiency. Shay is looking at individual genes whose functions are most affected.

"With zinc, there are elegant regulatory mechanisms that are specific and dramatic. If you add zinc to cells, genes turn on — it's a very rapid response," he says. "Improving zinc nutrition has implications ranging from growth, normal immune function, and even prenatal nutrition."

- **Brain peptides and neuropeptides.** Neuropeptides bind to certain cells in the brain and cause other interactions or behaviors to occur. Certain brain peptides increase appetite, whereas others may create preferences for particular foods, such as fats or carbohydrates. Some peptides act mostly early in the day, then decrease; others are low in the morning but increase throughout the day.

"Neuropeptides can have tremendous impact," Shay says. Theoretically, people

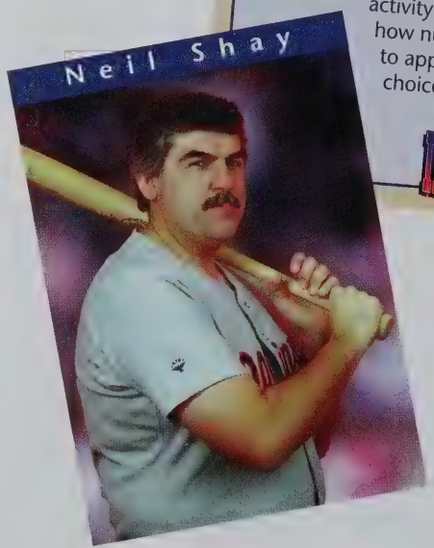
SHAY

Assistant professor, Department of Food Science, and member of Division of Nutritional Sciences and Biotechnology Center

Education:
- B.S., M.A., University of Massachusetts
- Ph.D. in biochemistry and molecular biology, University of Florida

Working philosophy:
This research may help scientists measure nutrient deficiencies, explain eating disorders, diabetes, and other health problems. It could explain how nutrients control the activity of certain genes and how nutrient intake relates to appetite and food choices.

Illinois All-Stars



could eat foods that would control the expression of peptides. Or there might be pharmacological approaches to control levels of expression in peptides. For agriculture, finding ways to selectively enhance feeding behavior could improve meat production or help bring animals to market faster.

- **Anorexia.** Brain peptides and low zinc appear to be factors in the development of anorexia. Some people may be predisposed to anorexia. Zinc deficiency can inhibit the desire for food and cause loss of taste. An inability to distinguish salt from sugar is one example of taste loss.

"The ability to taste is one phenomenon. The desire to eat is a separate one," Shay says. "If you feed growing laboratory animals a normal diet, their weight will increase with time. If you feed the same animals a zinc-deficient diet, they will not grow at the same rate as their normal counterparts.

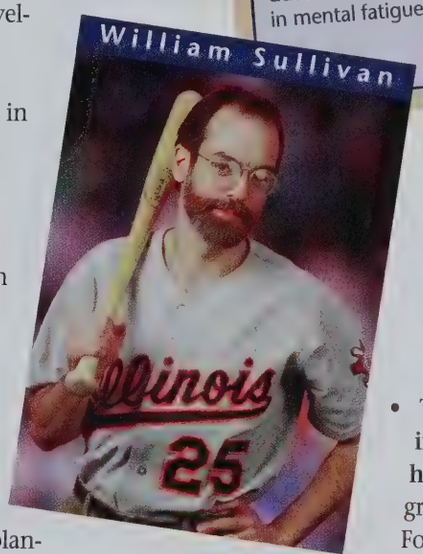
"Growing rats will eat more and more food; but, with zinc deficiency, food intake will remain constant or decrease slightly. We are trying to identify the neuropeptides responsible for this decrease in appetite."

- **Nutritional regulation of genes.** Conducted with H.R. Gaskins, UIUC Animal Sciences Department, these studies are aimed at one day producing natural diets or pharmacological strategies for reducing glucagon production that results from insulin deficiency in diabetics. For the experiments, scientists use a unique cell line derived from pancreas alpha cells. The glucagon-producing response of the cells to glucose and amino acid levels is tested using cells in culture. The cell culture system allows the nutritional regulation of glucagon production to be studied directly.

William Sullivan developed a passion for teaching and an enthusiasm for landscape design from his mentor Bill Nelson, UIUC professor emeritus of horticulture. The Glen Ellyn, Illinois, native also felt a pull to the social sciences.

"While working on my master's degree, I became interested in the relationship between people and nature, especially in the ways that nature is supportive of human functioning," Sullivan says. He developed these interests further by taking several environmental psychology classes at the University of Michigan.

Sullivan's social interests are reflected in such publication titles as: "Cluster housing at the rural-urban fringe: The search for adequate and satisfying places to live," and "A yearning for conservation: The conflict between citizen attitudes and economic development."



An early interest in teaching found Sullivan in front of students even while he was a student, and it keeps him in the classroom today. He teaches landscape design and is working to introduce computer-aided design into the university's undergraduate curriculum.

His research is focused on landscape design, environmental planning, and plant–people interactions. Last year, Sullivan helped develop several successful multimillion-dollar research proposals. This new research will involve collaboration with an interdisciplinary group of scientists. Looking to the next few years, he says he is excited to be part of a group "held together by the quest to understand the relationships between people and nature" and working to address issues of "creating places that are healthy and supportive of human functioning." Some of these new projects include:

- **National Consortium for Environmental Education and Training.** A three-year, $4.75-million grant teams Sullivan with colleagues at the University of Michigan, Howard University, Michigan State University, and Sonoma State in California. Funded by the U.S. Environmental Protection Agency, the researchers will look at innovative ways to enhance environmental education in K–12 classrooms.
- **The value of nature in urban public housing.** A two-year grant from the U.S. Forest Service will allow Sullivan and his collaborator, Frances E. Kuo, in partnership with the Chicago Housing Authority, to determine how the presence of nature affects people. They will look at how nature influences rates of absenteeism, job hunting, learning, and other factors associated with coping with poverty.
- **Environmental Extension Network.** This new pilot program, funded by the U.S. Environmental Protection Agency, supports an effort developed by Sullivan and University of Michigan collaborators to share information about environmental issues with small businesses and citizens.

Anita Povich, communications specialist, Office of Agricultural Communications and Education, and Tina M. Prow, science writer, Agricultural Experiment Station

SULLIVAN

Assistant professor, Departments of Horticulture and Landscape Architecture

Education:
- B.S., M.S. in horticulture, University of Illinois at Urbana-Champaign
- M.L.A. in landscape architecture, Kansas State University
- Ph.D. in environmental planning, University of Michigan

Working philosophy:
Natural environments and environments with natural elements have healing, positive impacts on human functioning. Contact with nature — a walk among trees or a window view of trees — produces consistent, measurable reductions in mental fatigue.

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THEN & NOW

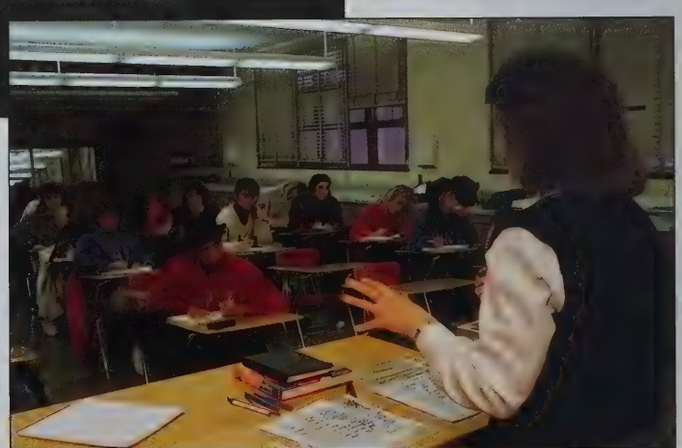
David Riecks and
Nancy A. Nichols

Learning is not attained by chance, it must be sought for with ardor and attended to with diligence.

—Abigail Adams (1744–1818), *Letter to John Quincy Adams,* May 8, 1780

In this age of innovation perhaps no experiment will have an influence more important on the character and happiness of our society than the granting to females the advantages of a systematic and thorough education.

—Sarah Josepha Hale (1788–1879), editorial, *The Ladies' Magazine,* January 1828



Things Change...

Courtesy Farm Security Administration, Library of Congress

'Tis sweet to spend one's time in the cultivation of the fields. —Ovid (43 B.C.–A.D. c. 18), *Ex Ponto,* II, vii, 69

...Yet Stay the Same

Riding the Rainbow of New Communications Technology

Nancy A. Nichols

New digital information technologies are spurring revolutionary changes in the way universities disseminate research results and other information to the public. Soon there will be an electronic alternative to virtually all informational print materials produced and distributed by the University of Illinois College of Agriculture. From two-page factsheets to 200-page books, all will be available via computers — in "cyberspace."

Developments in telecommunications technology during the past few decades have catapulted us into the Information Age. Important tools of the Information Age include televisions, telephones, computers, FAX machines, CD players, and VCRs. Every day the technology is becoming more affordable, more compact, and more personalized.

By the year 2000, an estimated 40 million households will be linked to a fiber-optic network that will bring us an unprecedented amount of information. Although much of it will be commercial entertainment, including 500-channel

This visualization study shows inbound traffic measured in billions of bytes on the NSFNET backbone (September 1991). The traffic volume range is depicted from purple (zero bytes) to white (100 billion bytes). Data collected by Merit Network, Inc.

TV and dial-up videos, a good deal of the information will be educational. The University of Illinois and other institutions throughout the nation are gearing up to take advantage of the new "information superhighway" to bring you more information more quickly and in more interesting formats than ever before.

Networking — the linking of computers and other electronic equipment in offices, laboratories, and homes around the world — is the key to improving the way in which the College of Agriculture shares its resources with the public. This new style of communicating has been building over a number of years, and it all started with something called the Internet.

What Is the Internet?

An electronic web of thousands of computer networks around the world, the Internet reaches an estimated 2 million computer terminals used by up to 30 million people in more than fifty countries. Thousands of Illinoisans now use the Internet for work or pleasure, and the numbers are growing daily.

The Internet got its start as a single computer network called the ARPANET, created by the Pentagon in 1969 to transmit military data around the world. Access to the ARPANET was originally limited to the military, defense contractors, and universities doing defense research. In the late 1970s, cooperative, decentralized networks serving universities and business came into being. More coordinated networks sprang up in the 1980s, providing nationwide networking to the academic and research communities. At the time, software called the Internet Protocol was developed to provide a standard so that computers from different manufacturers would be able to communicate with each other.

Then in 1984, the National Science Foundation began building supercomputing centers around the nation for conducting scientific research, one of which is located on the UI campus in Urbana-Champaign. To link researchers across the country with the five supercomputing centers, the National Science Foundation in 1987 established a new, very fast fiber-optic network called NSFNET, which soon replaced the ARPANET as the preferred mode of electronic communication among network users. NSFNET serves as the backbone linking the thousands of networks that now make up the Internet.

"Around the time the NSFNET was built, the Internet began growing by leaps and bounds, showing exponential gains in number of networks, human participants, and computers," writes Tracy LaQuey in her book *The Internet Companion: A Beginner's Guide to Global Networking*. Following the U.S. example, many countries around the globe soon set up their own networks and established links with the Internet.

A fact that is often not fully understood even by many regular network users is that no one entity or organization is "in charge" of the Internet. Rather, it's more like a confederation of compatible networks, each of which allows its users to communicate with users on other networks.

So, what began as a way for military researchers to collaborate on-line has expanded to a global network we now call the Internet. The longer it has existed, the more the Internet has evolved into a communications tool for use by the general public, though fully a third of its usage is still by scientists and researchers.

UI Researchers Get Connected

Researchers are using the new technology in two main ways: for collaborating with distant colleagues via electronic mail, or email, and for accessing information stored in distant databases. One such researcher is Harris Lewin, a UI animal geneticist in the College of Agriculture.

Lewin says that animal geneticists are a rather small group and that "everybody of significance in the world is on the Internet." He keeps up on the latest discoveries via a gene-mappers' bulletin board, a kind of network discussion group that allows scientists with like interests to share their ideas and discoveries informally. "The amount of information is increasing so rapidly that if you wait for the literature to be published, you're a year behind," Lewin says.

These days, scientists have a world of information at their fingertips. Not only are the UI library system's card catalog

Geneticist Harris Lewin regularly accesses animal-genetics databases around the globe from his office in the Animal Sciences Laboratory.

and other library resources available at the stroke of a few computer keys, but an enormous amount of information from scientific databases around the globe is also readily available.

Lewin regularly accesses faraway gene-mapping databases, including a swine genome database in Scotland and a cattle genome database in France. Genbank, a molecular biology gene-sequencing database, is another favorite. Lewin can do near-instantaneous gene-sequence matching via the database, which he accesses through the National Library of Medicine in Washington, D.C.

Before electronic communications, Lewin and his colleagues shared genetic data by mailing computer files on diskettes or just paper copies. "For a project in 1984, we sent out computer outputs that were 6 inches thick to several labs around the world," he says. At the time, his postage bills were quite high. "Now," he says, "I'm organizing a meeting to be held in Norway, and all materials, including invitations, are being sent out over the Internet."

The downside? "Now that I'm on email, everyone expects a response within 10 minutes," Lewin says. "Some mornings, I come in and find twenty messages from Europe in my email," whose senders expect a timely response. "It's a mixed blessing," he says.

Another way in which researchers are using email is to work more easily with distant co-authors. UI agricultural economist Sarahelen Thompson uses the network to collaborate with colleagues as far away as Taiwan. "What we send more than anything is manuscripts in progress," Thompson says.

"My previous style was mailing diskettes overnight at $10 a crack." Now, instead of waiting a week for revisions, Thompson gets some manuscripts back the same day they were sent — and saves money doing it.

College Comes Up with a Good IDEA

For several years, the UI College of Agriculture has operated its own computer network. Known as IDEA, Illinois Dial-up Extension Access is a wide-area network run by the Office of Computer Coordination of the Cooperative Extension Service (CES).

When established in 1987, the network was geared mainly to help CES staff members, both on campus and in statewide field offices, communicate and share information via electronic mail. It was an administrative time-saving tool. Since then, IDEA has opened its doors to all College staff and has expanded to include not only email but also subject-matter libraries and databases, an on-line news service (public bulletin board), and a variety of enhanced administrative applications (such as organization-wide calendars of upcoming events).

Recently IDEA has taken the College's computer-based communication services far beyond the state border. During the past year, IDEA established a two-way public link to the Internet, at the same time adopting as its new user interface the "gopher" search-and-retrieval system now employed by thousands of other information providers. Anyone in the world with access to the Internet can now get on the public portion of IDEA and read about what is happening at the College of Agriculture or retrieve infor-

New Library Brings Students Up to Speed

Plans for the new College of Agriculture Information and Alumni Center are on the drawing board, and its construction is on the university's priority list. This dream will soon become a reality; and, when it does, the College will at last have an information center for the Information Age.

Students will benefit most from increased access to rapidly expanding information technology. College of Agriculture librarian Carol Boast says that patrons are not able to make use of much of the technology that is available because the current facility doesn't have the space or the equipment.

The library now in use, located on the second floor of Mumford Hall, is inadequate for the demands of the College's 2,300 students and 600 faculty members. At 7,800 square feet, it seats only 50 people. Compared to the proposed building, which would contain 42,000 square feet of usable space, the current library can house only one-third of the College's 200,000 books and other materials. The rest are in other libraries, and some are even in storage.

Although the library has subscriptions to the major agricultural databases (AGRIS, AGRICOLA, and CAB, among others) on CD-ROM, they can be used by only one person at a time because there is only one station per database. This new technology takes the librarian out of the middle of the search for information. "And," Boast says, "students are literally standing in line to use the workstations."

Boast anticipates that, in the new facility, a network will make databases accessible from any computer terminal, and the new building will have nearly 100 available computers. Students will also be able to learn to use the technology in the new building's Microcomputer Teaching Laboratory. Such classes are impossible now, she says, because they would disrupt anything that was going on in the current library.

But students who are eager to get started have been teaching themselves. They are using the Internet to reach people all over the world when they need to send a message quickly. For example, students with environmental concerns used the

IDEA Gopher Information Client v1.12

Root gopher server: ilces

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      1.    ***** Help Information *****
      2.    ** Search Extension Information ** <?>
      3.    ** What's-New-on-IDEA-Gopher Server **
      4.  Adult-Life-and-Aging
      5.  Agriculture-Market-News/
-->   6.  Flood-Information/
      7.  Food-Preservation/
      8.  Food-Safety/
      9.  INTERPAKS/
     10.  IlliNet-Lines/
     11.  Illinois-Agricultural-Experiment-Station/
     12.  Mental-Substance-Abuses/
     13.  News-Releases/
     14.  Nutrition/
     15.  State-Fair-Results/
     16.  Urban-and-Community-Forestry/
     17.  Vegetable-Crops/
     18.  Yard-and-Landscaping/
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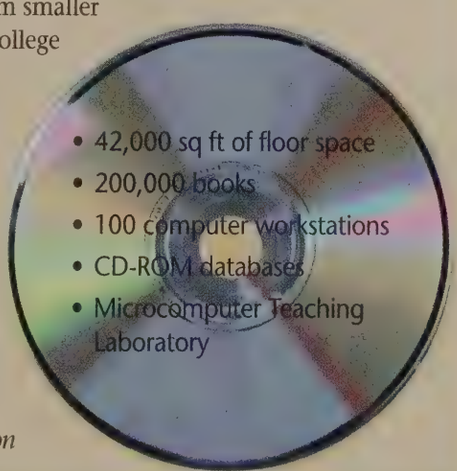
Press ? for Help, quit, prev menu Page 1/1

Envirolink network recently to reach Sierra Club members with news of a petition drive to halt logging on public lands. Recipients then sent the message to other persons interested in environmental issues.

Satellite uplink and downlink facilities can also bridge physical distances instantly. Satellite facilities in the new library will make it possible for an Illinois student to enroll in a class taught at Kansas State or enable a faculty member to attend a meeting by teleconferencing instead of flying across the country the old-fashioned way.

So you won't have to be on campus to benefit from this new information center. Carol Boast's goal is to make the library accessible to everyone in the state. Right now, anyone who has access to the Internet has access to the library cataloguing system. Bridget Lamont, director of the Illinois State Library, wants to see all 2,500 public libraries in the state equipped with the basic computer equipment needed for Internet access. When that happens, people across the state will be able to shop for information without leaving their home towns and maybe even their homes.

College Development Office director Lynette Marshall says that individual $1-million donations for the new building have come from the Funk family in Bloomington, Richard and Sally McFarland of Indianapolis, and Florence Odell, whose husband was on the agronomy faculty for 30 years. But a broad range of support for the new building comes from smaller contributors, prominent among them college faculty and staff who see that the new library is badly needed.



Ground breaking for the new building could begin as early as this fall if the State Assembly votes to match the $7 million in private funds already donated to the project. When the dream becomes reality, students in the College of Agriculture will have a head start in today's world. — *Phyllis Picklesimer, publications editor, Office of Agricultural Communications and Education*

mation from one of the network databases.

Journalists are among those who have found IDEA useful. A recent issue of *Quill*, a magazine for journalists, listed IDEA as a good source for inexpensive data. Last year, one of IDEA's databases focused on the Midwest flood and, among other things, provided journalists covering the event with "a handy list of state agency contacts and phone numbers."

In addition to providing the agency listing, a quickly organized CES flood-information team — including media specialists, computer specialists, and subject-matter specialists — put a wealth of information about how to respond to the flood damage on IDEA. In one month at the height of the flooding, IDEA registered more than 1,100 external connections across the Internet, and 96 flood-related articles were accessed 6,130 times. As Floyd Davenport, IDEA's system manager, observed, "I can't tell you how the information was used, but someone was definitely interested."

Besides the flood information, current databases include "Food Preservation," "Yard and Landscaping," "Urban and Community Forestry," "Market News," and "INTERPAKS" (a collection of educational materials pertaining to international agriculture). CES news releases and newsletters are also distributed over IDEA. The newsletters include the *Pest Management & Crop Development Bulletin*, which gives farmers weekly updates on pest problems and crop development during the growing season. *Home, Yard and Garden Pest Newsletter*, targeted at nursery operators and homeowners, is another popular network offering. These databases, news releases, and newsletters can be accessed through the Internet by IDEA's host name: *idea.ag.uiuc.edu*.

New IDEA projects include the development of an almanac server that will allow users to send in requests for information and more easily enable the College to make mass mailings. The almanac server will also let users subscribe to agriculture-related newsgroups. Also in the works is the Adult Agriculture Education project, sponsored by a consortium of agricultural education

providers around the state and featuring a database with details on upcoming events and activities in agricultural education statewide.

As part of its outreach effort, the Office of Computer Coordination recently teamed up with the Lincoln Trail Libraries System in central Illinois to provide its IDEA on-line information services to residents of the area via computer terminals in public libraries. The office also plans to provide training programs for new Internet users in rural areas across the state.

Further information on IDEA can be obtained from Dan Cotton, head of the CES Office of Computer Coordination, via Internet email (*d-cotton@uiuc.edu*) or by calling (217)333-9513.

A National Agricultural Research Database

To give U.S. citizens even greater access to network resources, Vice President Al Gore and other federal leaders are pushing a $2-billion, five-year program to build a National Information Infrastructure. The new infrastructure will increase the speed of the current NSFNET backbone and broaden the availability of networking in an effort to comprehensively link the nation's schools, hospitals, and other community centers to the Internet.

As part of this new federal initiative to provide electronic information resources, the USDA Cooperative State Research Service has begun an effort to produce a national agricultural research, extension, and teaching accomplishments database, connecting a variety of information users with the land-grant university system. The database will give Internet users such as librarians, journalists, environmentalists, lawmakers, and businesses a broad range of accurate, timely, and understandable information about the nation's agriculture.

The database will be sorted by the following important topics:

- Food quality and safety
- Water quality
- Environment and natural resources
- Diet and health
- Family and youth development
- Sustainable agriculture
- Technology and agriculture
- Farm management
- Rural development and rural health care

The new database will be up and running within two years, with important contributions from the UI. According to Don Holt, director of the Illinois Agricultural Experiment Station, the College of Agriculture will provide information on the results of several promising research initiatives, such as genetic engineering of swine, high-oil corn, disease control in vegetable crops, sustainable production, and vertical coordination in agricultural markets.

Holt hopes that the new database will benefit not only interested individuals but also the public at large. "Through media use of the database, the public should be better informed about the size, scope, and quality of agricultural research projects under way at the University of Illinois," he says.

Audio Communications Go Digital

Advances in digital electronic communications within the College have not been limited to computer networking. As early as 1989, CES began converting to a digital system for audio communications when it upgraded TeleNet, the College's twenty-year-old dedicated audio-conferencing system. The computer-controlled audio "bridge," which is at the heart of the system, is now fully digital — offering cleaner, crisper sound for conference participants. Users can dial into a conference from anywhere in the United States, and the system can accommodate as many as forty-eight simultaneous conferences. The system averages about eight conferences per day, making it possible for staff, administrators, students, and members of Extension's many publics to interact with each other — all via a phone call from their homes, offices, or even a mobile location.

Darin Eastburn, a CES plant pathologist who needs to provide timely information about plant-disease outbreaks around the state, is finding creative ways to use the new communication technologies. During the growing season, Eastburn

Hitchhiker's Guide to the Information Superhighway

To learn more about electronic communications, try one of the publications listed here. Note that *The Whole Internet User's Guide & Catalog* is currently being revised by author Ed Krol, who is assistant director of the Computing and Communications Service Office here at UIUC. Krol says that, among other things, the revised edition will include much more information on World-Wide Web, one of the latest document-searching tools for the Internet.

- *The Internet Companion: A Beginner's Guide to Global Networking*, by Tracy LaQuey. 1993. Reading, Massachusetts: Addison-Wesley Publishing Company.
- *The Whole Internet User's Guide & Catalog*, by Ed Krol. 1992. Sebastopol, California: O'Reilly & Associates, Inc. (Currently being revised.)
- *Wired* magazine, published monthly. Single copies available on newsstands; subscription information available via email (*subscriptions@wired.com*) or by telephone at (800)769-4733.
- *The Virtual Community: Homesteading on the Electronic Frontier*, by Howard Rheingold. 1993. Reading, Massachusetts: Addison-Wesley Publishing Company.

Universities Help with Community Computing

Besides offering their own on-line information services, many universities are helping their local communities to establish community computing services. A current example is Prairienet, located in Champaign-Urbana and supported by the UI Graduate School of Library and Information Science. Other offices involved in the project are the National Center for Supercomputing Applications (one of the nation's five supercomputing centers) and the College of Agriculture's Office of Computer Coordination.

Prairienet is affiliated with the National Public Telecomputing Network (NPTN), a Cleveland-based organization. Patterned after the National Public Radio model, NPTN aims to provide inexpensive yet high-quality electronic communication services in communities across the nation. NPTN currently provides advocacy and services to fifteen affiliate "Free-Nets" across the nation, and that number is growing rapidly. About forty-five additional communities will become NPTN affiliates in the near future.

Organizers of Prairienet hope to link community members located in diverse places throughout east-central Illinois, including nursing homes, hospitals, schools, government offices, and businesses. The broad goal is to integrate computer networking into the region so that a wide range of people can use it for work and play, to improve the economy, to provide education, to increase civic involvement, and to provide access to developing information and communication services. It specifically plans to include a clearinghouse on early childhood education, a local events calendar, and dietary information and discussion groups.

Prairienet will soon be accessible at no cost in any public library in five counties in east-central Illinois, or Illinois residents will be able to get a free subscription for their home computers. Out-of-state users will pay $25 per year for a subscription. More information about Prairienet can be obtained by dialing in from your home computer to (217)255-9000. Set your modem for 1,200 or 2,400 baud, N-8-1. Press **Return** a few times to get the login prompt, and login as "visitor." Internet users can "telnet" to *prairienet.org*. Or call administrative director Jay Greenberg at (217)244-1962.

Another local project affiliated with Prairienet is CCNet (Champaign County Network), an effort led by the Champaign County Chamber of Commerce and supported by the local Economic Development Corporation, Convention and Visitors Bureau, and Cablevision to provide quicker transmission of data than is available over the current Prairienet dial-up system. Five task forces have been set up to steer the group's efforts: education; health care; small business; agribusiness; and community services, government resources, and libraries.

CCNet will provide access to Prairienet as well as to Mosaic, a new piece of software developed by the National Center for Supercomputing Applications. Mosaic allows users to gain access to documents, graphics, photographs, animation, and video that are stored on the thousands of computers linked to the Internet. The way Mosaic works is to present a document on a particular topic, which has key words and phrases highlighted. The user can choose any key word or phrase, initiating a search for information related to the key word or phrase throughout all Internet-connected databases. In a sense, it turns the entire Internet into one big searchable database. Information about CCNet is available from Mick Moore of the Champaign County Chamber of Commerce, (217)359-1791.

As their name implies, Free-Nets provide *free* networking services to members of the communities they serve. "What significantly distinguishes Free-Nets from other networks is that the Free-Nets provide a base-level set of resources that every citizen should have a right to," says Bob Pauls, executive director of the Shawnee Free-Net, another new network in southern Illinois. "Like public radio, we believe in the public having access to free, quality material as an alternative to commercially available services," Pauls says. Shawnee Free-Net is supported in part by Southern Illinois University at Carbondale. The pilot network is scheduled to begin operation this spring. For more information on the Shawnee Free-Net, call (618)549-1139.

In addition to offering free access, Free-Nets work to provide a friendly interface with the Internet, which can otherwise be quite confusing and intimidating. A good example of a user-friendly community computing service is Heartland Free-Net, serving Peoria, Bloomington-Normal, and other central Illinois communities. Heartland's menu system is set up so that even a novice can quickly get oriented to electronic communications.

Heartland Free-Net is supported by a number of public and private groups, including Bradley University in Peoria, Illinois State University in Bloomington-Normal, and Caterpillar, Inc. Registration is free to Illinoisans, $10 for out-of-state users. For information, call (309)667-2544 in Peoria or (309)438-2300 in Bloomington-Normal. The Internet address is *heartland.bradley.edu*.

regularly participates in TeleNet conferences on crop conditions. In addition, Eastburn provides weekly updates during the growing season for commercial vegetable growers via voicemail messages (a digital telephone information line he operates from his office on the UI campus). He posts the same information on IDEA as well.

Another promising technology is "audiographics," which combines two separate digital-based technologies (audio and computer conferencing) to provide a richer, more interactive environment for distance learning. Using audiographics equipment, users not only hear what is said at each location, they can also see it.

"Audiographics has a lot of potential for long-distance disease diagnosis," Eastburn says. He is encouraging farmers to bring their plant specimens to CES field offices equipped with audiographics technology (currently in the Springfield area only). There, a picture of the diseased specimen can be sent electronically to the plant pathologists on campus in Urbana-Champaign for quick prescreening. For accurate diagnosis, most specimens will still need to be mailed to the UI Plant Clinic for thorough lab analysis. But Eastburn says the new visual prescreening method is a vast improvement over the old method of having clients describe the disease over the phone.

"Put it under the camera, ship it over here, and I'll help you identify the disease," he says.

Even Publications Get Wired

For the past seven or eight years, as anyone familiar with the term "desktop publishing" can testify, computers have profoundly changed how printed publications are produced. That has certainly been true in the College of Agriculture, where for several years all prepress publications work has been computer-based.

Now the College is about to enter a new era in which the document in electronic form may become the most important source document. At least that's the goal of a three-year pilot project in the Information Services unit within the Office of Agricultural Communications and Education. Working closely with the CES Office of Computer Coordination, Information Services staff will work to transfer existing publications into a master digital format, retaining all the graphic richness of the paper-based original. Once these materials are in a digital environment, the "infobase" containing these electronic documents will have vastly more powerful searching tools than are possible in paper-based materials. The plan is to eventually make all of the College's informational publications available in this visually rich electronic format and to share it with the public either on CD-ROM or over the Internet.

About the Future

It has been argued that the new electronic communications technology will spawn a new kind of global democracy, breaking the hold that politicians and other power brokers have had on highly valued information. Nowadays, information from global power centers such as Washington, D.C., is more free-flowing and easier to obtain than ever before. A vast number of government documents — from the President's speeches to Securities and Exchange Commission data on businesses — are now on the Internet.

The Internet could be a new communications model, allowing for unfiltered, "many-to-many publishing" rather than the traditional hierarchical one-to-many approach. A new "global village" is now possible, allowing people in distant places to share ideas, information, and concerns.

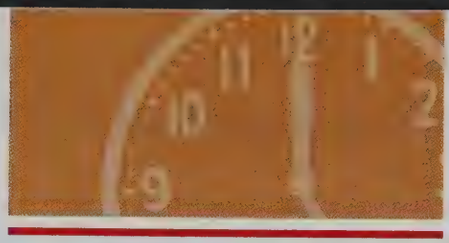
But the new technology also brings with it some concerns. For example, is there a limit to how much information the human mind can handle, and is the new technology exacerbating the problem? Ann Reisner, associate professor of communications in the Office of Agricultural Communications and Education, says that researchers these days are suffering from "cognitive overload" — an inability to synthesize the massive amount of new data. "We lose the ability to synthesize because information is coming in too quickly and there's too much of it," Reisner says. Other communications experts might argue that computers also have the potential to help rid us of unwanted information in the future through increasingly sophisticated searching and "filtering" features.

Other questions include:

- Because there is great expense in building and maintaining high-tech communications systems like the Internet, will the federal government opt for privatization of electronic communication networks, increasing fees for network users (many of whom now pay little or nothing)?
- Will the public have a say in how electronic communication evolves, or will the government and private industry make the decisions?
- Will information sources be held liable for the recommendations they make or advice they give over the Internet?
- How will the new technology affect copyright and privacy laws?
- Is electronic communication creating a virtual global community or a global information elite? (Will the costs of the required technology be prohibitively expensive for people in poorer nations? If English is the dominant language of the Internet, how will the world's 5 billion non-English speakers participate?)

New technology always brings new questions and challenges. In the case of electronic communications, a major challenge for information providers such as the UI College of Agriculture will be to put people's needs first — technology is only as good as its ability to improve people's lives. As we approach the twenty-first century, the College will continue to provide information based on the public's needs, using the new technology to meet those needs more effectively and creatively than ever before.

Nancy A. Nichols, publications editor, Office of Agricultural Communications and Education



College Milestones: Our Tracks in Time

Tina M. Prow

There was a time when farmers planted by the phases of the moon and harvested about a third or less of the yield they do today — if they didn't lose the crops to weeds, insects, diseases, and weather. Rural areas were dark because providing electricity to remote farmsteads was considered unprofitable. In those days, malnourishment was common among the wealthy as well as the poor.

The need for basic food and agricultural research prompted legislators on March 2, 1887, to pass the Hatch Act, designed "...to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture, and to promote scientific investigation and experiment respecting the principles and applications of agricultural sciences."

A year later, an Agricultural Experiment Station was organized at the University of Illinois. Building on research set in motion at the UI as early as the 1860s, Illinois Station scientists carried out more than 100 experiments in dairy, cattle, and crop management within two years. They published eleven bulletins. That momentum has continued for more than a century, helping Illinois farms become more efficient and profitable and improving the quality of life of every citizen.

Visitors to the UI Morrow Plots, a national historical landmark, can see one of the earliest research projects. Started by Manley Miles in 1876 to "study the long-time effects of different cropping systems with and without soil treatments on one of our best dark-colored prairie soils," the Morrow Plots are the oldest continuous soil experiment plots in the United States and have the oldest continuous corn plot in the world.

Breeding for Better Production

Corn breeding has almost as long a history at the Station. Two 1884 graduates, George W. McCluer and Thomas F. Hunt, conducted self-fertilization and cross-fertilization corn experiments as early as 1886. Archibald D. Shamel, Perry G. Holden, Edward M. East, and Louie H. Smith continued those experiments, which helped provide the foundation for hybrid corn. Many of their students became the breeders who developed hybrid corn for private companies. By 1939, an estimated 70 percent of Illinois corn farmers were planting hybrids and harvesting more grain than ever before. Hybrids are now the norm.

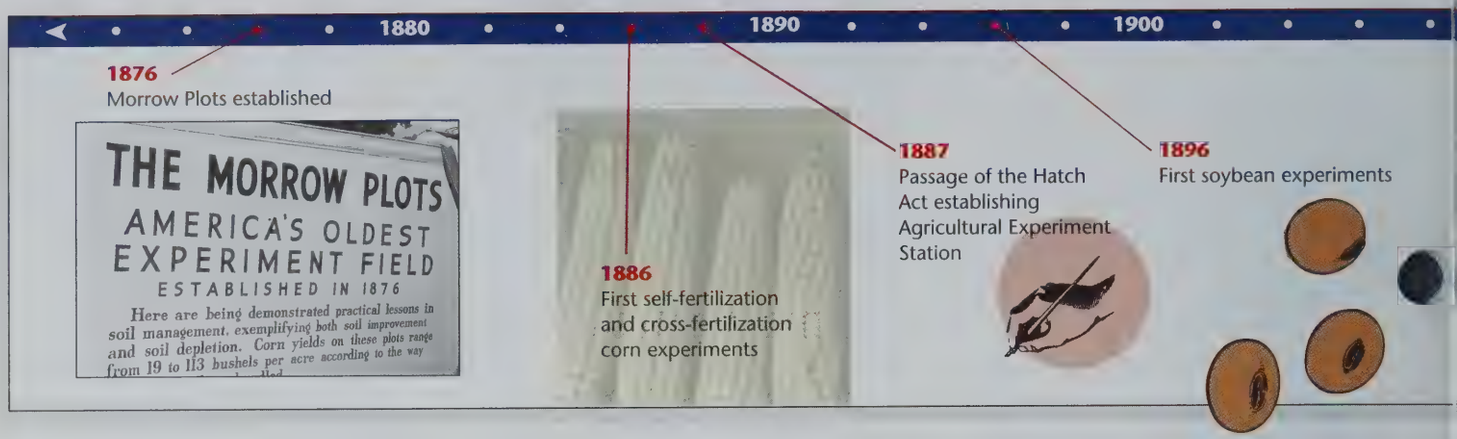
Early corn research also focused on manipulating oil and protein in kernels. Begun by Cyril G. Hopkins in 1896, experiments were continued by D.E. Alexander, Earl R. Leng, and John W. Dudley, culminating in a 94th generation in 1993. Researchers adapted new technologies, such as infrared spectroscopy and nuclear magnetic resonance spectroscopy (NMR), for this research. NMR is used routinely now in plant breeding as a nondestructive way to analyze seed.

Station researchers also recognized potential for soybeans and began studying the crop in 1896, despite the fact that few farmers planted soybeans. Clyde M. Woodworth worked to improve soybean varieties in the 1920s. By the 1950s, after UI scientists showed farmers that this legume could be harvested efficiently with a combine and used in feed, soybeans replaced oats as the second most important crop after corn.

Incorporating disease resistance into soybeans and other crops was an early goal of Station plant pathologists, who worked closely with scientists of the USDA Agricultural Research Service (ARS). The collaboration of plant pathologists and plant breeders made it possible to avert serious disease threats, such as wheat streak mosaic in 1940 and southern corn leaf blight in 1970. Station and ARS scientists were among the first to identify many disease threats, determine the causes, and find sources of resistance for breeders.

Early breeding programs were broader in scope than corn and soybeans. Although Illinois was not a leading oat-producing state, Charles M. Brown contributed to development of varieties that came to dominate oat production in the Midwest.

Similarly, Illinois did not lead the nation in apple production but did carry out some of the most innovative breeding and testing programs. Particularly important was research, conducted jointly with other states, to test a new English technique for grafting fast-growing apple trees to slow-growing bases. The resulting dwarf trees transformed the apple industry. Instead of growing 40 to 60 trees per acre, growers today plant 100 to 250



dwarf-stalk trees per acre and pick earlier, heavier, and higher-quality crops.

Breeding is only one crop research area where Station scientists made dramatic, lasting contributions to improve farm production. Scientists also pioneered research in crop physiology, particularly in such areas as effect of light on pollination, uptake of potassium, herbicide action, and nitrogen metabolism. Richard H. Hageman, whose writings were often cited by fellow scientists, used classical breeding techniques to alter enzyme levels in plants years before "genetic engineering" became common.

The Chemical Age

> The combination of better varieties and chemicals for pest control led to an agricultural revolution from the 1940s to the late 1950s. Corn yields went from 47 bushels per acre in 1945 to 94 bushels per acre in 1965. Entomologists, weed scientists, soil scientists, plant breeders, all working in their own fields, also worked together. Everything happened so fast — and for once, there was amazingly quick adaptation from plots to farms. It was the dawn of the Chemical Age. — *Pete Petty, Professor Emeritus, Agricultural Entomology*

At the forefront of this new era, Station researchers anticipated both the benefits and the problems of pesticides. Fred W. Slife, Ellery L. Knake, and Marshal D. McGlamery conducted some of the first chemical weed management studies in the country. The pressing question was: Do weeds reduce yields enough to warrant spending money on chemical management? UI researchers looked at different weeds, herbicides, and management strategies at several of the Station's research farms around the state.

As with herbicides, insecticides changed the way farmers managed insects. UI scientists conducted research to help farmers use pesticides wisely. At the same time, they remained alert for problems, sounding an alarm over persistence of such pesticides as DDT, aldrin, and heptachlor. In 1949, Petty organized what would become an annual conference to discuss pest management research findings under the banner: "wise and judicious use of pesticides." Environmental concerns were evident in the first proceedings, which included papers on the effects of pesticides on aquatic life and wildlife. Early Station research served as a basis for the state's pesticide applicator training program developed in the mid-1960s.

Protecting Illinois's Soils

Many of the management practices in place today hinge on soil data collected since 1937. Alfred U. Thor, James G. Laverty, Theodore R. Peck, and Russell T. Odell are just a few of the pioneers who developed methods for soil mapping, analysis, and testing used in Illinois and other states. As commercial fertilizers became available, Illinois researchers conducted some of the earliest fertility management research in corn production.

In addition to soil fertility, erosion was a concern of Station researchers. George E. McKibben, working at the Dixon Springs Agricultural Center near Simpson, conducted some of the nation's first no-till studies. His pioneering erosion-control work produced satisfactory corn yields on sloping soils. Those findings were an important addition to earlier erosion control studies, such as terraces, conducted by Station agricultural engineers. As the plow gave way on some farms to reduced tillage and conservation acreage, the Station's early herbicide research proved pivotal to weed management.

Improving Efficiency, Profitability

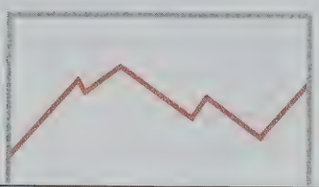
Farm cost studies, started by W.F. Handschin in 1917 and continuing today, give Illinois one of the most complete farm production and economic databases in the country. The need for information on economics, business, and marketing to help producers farm more efficiently and profitably became increasingly critical as both yields and input costs rose.

> Helping keep agriculture on an even keel — stable and profitable — that was our goal. We had the largest Farm Business–Farm Management program in the country. It has been largely self-financed by Illinois farmers, the most innovative leaders in demonstrating good farming methods and profitable farming methods. — *Harold Halcrow, Professor Emeritus, Agricultural Economics*

1910 • • • • 1920 • • • • 1930 • • • • ➤

1916
Tractor research begins, leading to use of rubber tires and gasoline

1917
Start of farm cost studies, leading to one of the world's most complete farm production and economic databases



1930
First oak-forest growth and yield tables produced with data from Sinnissippi Forest

1930s
Food scientists describe process for using aerosol cans for food products

1936
Julia Holmes and Janice Smith study calcium needs of children

In the 1920s, C.L. Stewart's plan for making payments to farm product exporters so that U.S. prices could be maintained above world levels became a cornerstone of the national farm program for corn, wheat, cotton, and other products.

Many of the ideas explored in the early days of agricultural economics laid the groundwork for some of today's issues. Crop insurance based on an actuarial structure, now a sixteen-state research project, was a theory Harold Halcrow put forward in 1948. Through the years, Station agricultural economists accumulated a wealth of information and analysis on alternatives to property tax and other tax issues affecting Illinois agriculture.

In marketing, the notion of making grain grades reflect differences in value, proposed by Lowell Hill in the 1970s, resulted in a 1986 amendment to the U.S. Grain Standards Act. Hill's proposal provided for more accurate descriptions and measurements of grain quality to help buyers and sellers arrive at fair prices, to improve quality, and to ensure equitable treatment among producers.

Improving Nutrition

Although international markets are important today, a century ago the market for grain was primarily the state's livestock. Animal-science researchers were leading contributors to early knowledge of feed nutrition for beef cattle, dairy cattle, swine, poultry, sheep, horses, and even humans and their pets. UI scientists defined more amino acid requirements of pigs and poultry than any other university in the country. Their contributions toward improving animal nutrition ranged from developing a high-energy broiler diet, to defining how to feed bacteria in the rumen, to more recently identifying taurine as a critical nutrient for cats.

Earl Swanson, a UI agricultural economist working with animal scientists, demonstrated a method in 1955 for calculating minimum cost for feed mixes using mathematics and the then-new computers. Initially ignored by the industry, the method is a standard procedure now.

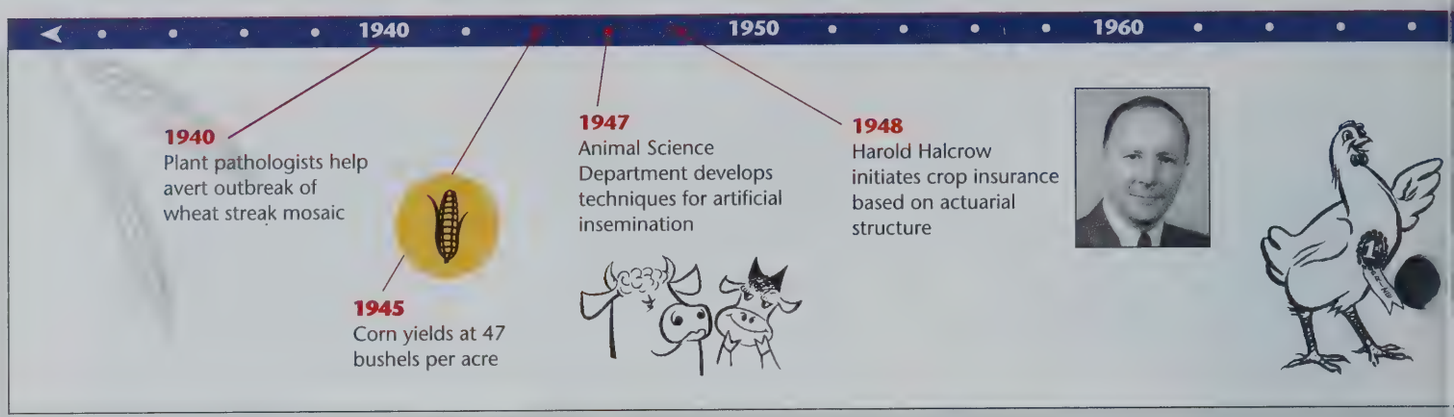
> University of Illinois scientists, from the beginning, have had some very new, very revolutionary ideas. Some research is not appreciated right away; it takes courage to continue research in the face of doubt and criticism. — *David Baker, Professor, Animal Sciences*

The first to demonstrate that a baby pig is unable to utilize sugar, UI animal scientists also changed swine production dramatically in the 1950s when Gene Becker showed that soybeans could replace meat scraps in a balanced diet. Extension specialists Harry Russell and Dick Carlisle carried this research to the field, where it was not accepted at first. Within a few years, however, 90 percent of the swine rations fed in the United States were built around corn and solvent-extracted soybean meal.

Also revolutionary was artificial insemination, developed from Glenn Salisbury's research in 1947. With this method of breeding, dairymen needed half as many cows, and stored semen could be used to produce offspring long after the source was unavailable. By the mid-1950s, the U.S. dairy herd was cut by half. This early research on artificial insemination, which included studies on timing for insemination, also proved valuable in human fertility research.

UI animal scientists have a history of providing key information to researchers working on human health issues. As early as 1915, Harold H. Mitchell was evaluating biologically the capacity of dietary protein sources, such as egg protein, meat protein, or vegetable protein, to meet requirements for amino acids. He researched the mineral requirements of animals and humans and made the first analysis of the composition of the entire human body. Building on his work, William Rose, a biochemist who in 1938 synthesized the last amino acid known to be essential, identified amino acids necessary to maintain good health. In 1965, H.M. Scott published the first work on an "ideal profile" of amino acids for poultry.

> The early research allowed the UI to become the world leader it is today in chemically defined diets across species — chicks, pigs, cats, rats, mice, dogs, humans. There are implications for humans in much of the work in animal research. — *David Baker, Professor, Animal Sciences*



From Farms to Supermarkets

Getting foods from farms to the food industry and ultimately to consumers is possible in part because of Station research in food uses, processing, packaging, and safety.

While colleagues in animal sciences assessed soybeans for livestock feeds, other researchers looked for ways to integrate the protein-rich crop into human foods. Jean I. Simpson evaluated methods for preserving and preparing green soybeans and soy flour, sprouts, milk, and curd in the 1940s. As a result, the UI became a major contributor of processes for preparing soy foods.

UI food science researchers were imaginative in the quest to bring more foods to more people. As early as the 1930s, researchers described a process for using aerosol cans for food products — canned whipped cream later resulted from a collaboration of chemists with dairy and food scientists. They also helped devise a method for continuous pasteurization of ice-cream mixes, an energy-efficient process most commonly used today. Slow to be adopted were plastic film packages for thermally processed foods and paper containers, staples in packaging today.

> It took some 20 years for paper milk containers to catch on. Then developments mushroomed in related areas, such as homogenized milk in paper cartons. It became acceptable in part because consumers could not see that the creamline was missing. — *Joe Tobias, Professor Emeritus, Food Science*

UI dairy researchers provided some early bacteriological safety data on homogenization. Another development on the milk front was a preservation process Paul H. Tracy helped to perfect so that the military could have powdered whole milk during World War II. Robert M. Whitney used powdered milk to pioneer flavor chemistry, with a goal to prevent off-flavors. A significant contribution from that research was training of farmers and students, who would work in industry, to identify off-flavors and defects and their causes. This research led to innovations in food quality and safety.

What foods consumers chose to eat and why were the focus of Station surveys, among the nation's first on diet and health. A 1936 home economics study, directed by Julia O. Holmes and Janice M. Smith, on calcium needs of children was the first of its kind in the country. Basic studies to improve diets in the 1930s helped researchers demonstrate the importance of vegetables for vitamin A, show that lactose enhances absorption of calcium and magnesium in children and young women, and outline daily mineral, protein, thiamine, and riboflavin requirements. Over the years, human nu-

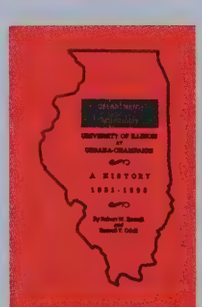
Further Reading to Take You Back in Time

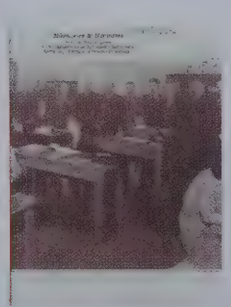
A History, 1951–1988. Department of Agronomy, University of Illinois at Urbana-Champaign. Robert W. Howell and Russell T. Odell, Professors Emeriti. 1988.

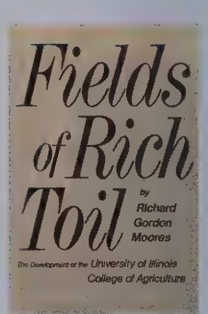
Fields of Rich Toil. The Development of the University of Illinois College of Agriculture. Richard Gordon Moores.

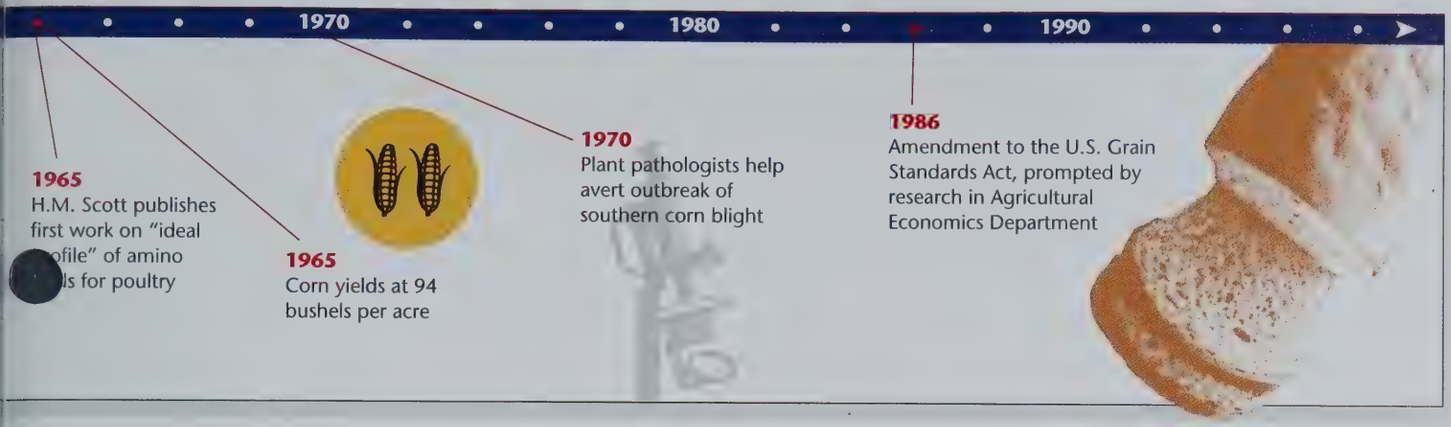
Milestones & Memories from the First 50 Years of the Department of Agricultural Economics. University of Illinois at Urbana-Champaign. Franklin J. Reiss, Professor Emeritus. September 1982.

Station Centennial. Illinois Research. Winter 1987/Spring 1988.









trition research has ranged from these basic studies of the nutritive value of foods to the relation of diet to heart disease, cancer, and immunity.

Labor-saving Research

Especially in rural areas, life was forever changed by UI researchers whose work helped free farm families from labor-intensive, day-to-day chores. Station researchers designed kitchen space to make meal preparation less tedious and barns to make animal production more efficient. One of the most important projects was rural electrification. By measuring power used on model farms, Emil W. Lehmann and Ray I. Shawl showed that providing electricity to remote farmsteads could be profitable for power companies and beneficial to farm families.

> Electrification removed some of the drudgery of farm activities. Producers didn't have to be workhorses; they could use their talents in other areas of the farm. — *Ben Jones, Professor Emeritus, Agricultural Engineering, and Associate Director, Illinois Agricultural Experiment Station*

UI research in machinery innovations helped free producers from work that was time-consuming, tedious, and sometimes dangerous. Because of tractor research, begun in 1916, farmers use rubber tires instead of steel wheels and gasoline instead of kerosene. Station researchers adapted combines to harvest soybeans, a key to increasing the acreage. In the 1950s, George Pickard's basic research led to the design of a combine used to harvest and shell corn in the field today.

As livestock agriculture evolved to intensive production, Station agricultural engineers pioneered work on handling livestock waste in livestock buildings. They conducted some of the earliest feed research on use of grinders and automated conveyance to make confinement livestock handling practices practical.

Windbreaks and Trusses

While some Station scientists focused on food and agriculture, others made significant gains in forest genetics, management, protection, and wood technology. The first UI forestry plantation, The Forestry, predates the Morrow Plots. Research conducted at The Forestry helped foresters prescribe species for windbreak, fuel wood plantings, and other wood needs of Illinois residents. A remnant of the area still serves the public as Illini Grove, a recreation area on the UI campus in Urbana.

Another important area of UI forestry research is the Sinnissippi Forest, a privately owned forest in northwestern Illinois. Oak forest growth and yield tables generated there since 1930 are still used today. A staging area for UI and multiagency research, the Sinnissippi Forest continues to provide data on regional genetics, Scotch pine adaptability, and the impact of insect pest and disease organisms on Illinois forests.

In addition to finding better methods for managing and protecting Illinois forests, UI foresters have provided leadership in genetics research. In the 1960s, J.J. Jokela's successful search for rapidly growing clonal selections of native eastern cottonwoods benefited poplar breeding programs throughout the world.

The result of UI forestry research to improve wood products is all around us. Charlie Walter's on-site treatments are used to protect wooden fence posts and utility poles from fungi and termites. Trusses with metal plates instead of nails, based on Don Percival's designs, have become an industry standard for their strength and durability. The wood industry currently is adopting Poo Chow's technology to simulate weathering of wood. This technique reduces the time required to predict durability from thirty years in field testing to two weeks in laboratory simulation.

These are just a few accomplishments of some Station scientists who worked, often in collaboration with researchers at the UI and elsewhere, to fulfill the Hatch Act charge to "aid in acquiring and diffusing...useful and practical information...." Special thanks to the following for resources, comments, and shared memories: David Baker, Wayne Bever, D.W. Chamberlain, Jeff Dawson, Harold Halcrow, Gary Heichel, Lowell Hill, Jeff Dawson, Ben Jones, Ellery Knake, Daniel Meador, Pete Petty, Earl Swanson, Joseph Tobias, and Willard Visek.

Tina M. Prow, science writer, Agricultural Experiment Station

College Changes with the Times

In December of last year, the College of Agriculture faculty approved a reorganization proposal for the College. These changes, which were proposed by Dean W.R. Gomes but derived from the examinations and recommendations of several groups within the College, must go through several additional layers of approval by the university and state and probably won't occur for a year or more.

College faculty voted yes on a name change for the College. The new name would be College of Agricultural, Consumer, and Environmental Sciences. The College would contain seven academic units: Agricultural and Consumer Economics; Agricultural Engineering; Animal Sciences; Crop Sciences; Food Science and Human Nutrition; Human and Community Development; and Natural Resources and Environmental Sciences. There would also be two interdepartmental, intercollegiate programs: Human Ecology and Nutritional Sciences.

Don Holt, Director of the Agricultural Experiment Station, stresses that "we haven't eliminated programs—we've reorganized them to make them more efficient. Our research and training in these areas are still important, and we will support the same research programs, but they'll be located in different units.

"Our hope is that the new organization will increase our ability to compete for outside funds. For example, the new Department of Natural Resources and Environmental Sciences will attract more attention to our research in these areas. We also think that the reorganization will reduce administrative costs, thus allowing us to put more money directly toward research." — *Terri Stone, Office of Agricultural Communications and Education*

Farsighted C-FAR

A new coalition, Illinois Council on Food and Agricultural Research (C-FAR), is being formed with the mission to encourage a profitable, consumer-sensitive, and environmentally sound food and agricultural system in Illinois and the United States.

C-FAR's membership is far-reaching and includes food and consumer associations, farmer organizations, environmental groups, farm commodity organizations, government agencies, sustainable agriculture groups, and individuals interested in food and agriculture. C-FAR is independent of any one organization. It will advocate relevant, high-quality, and adequately funded research and related outreach programs.

Leonard Gardner, C-FAR's executive secretary, is excited by the group's considerable potential. "To my knowledge, this is the first time that anyone has made such a strong effort to bring about a coalition of these disparate parts," Gardner says. "While we don't pretend to represent all citizens of Illinois, we believe that our emphasis on research is beneficial for society as a whole, not just for members of C-FAR."

C-FAR's mission is given greater urgency by Illinois's poor ranking in overall funding and in state revenue support for food and agricultural research (22nd and 29th, respectively), despite traditionally ranking fourth or fifth in gross agricultural production nationally. C-FAR hopes to put Illinois in the top ten for state support of food and agricultural research.

A long-term goal of C-FAR is to strengthen lines of communication between the food and agriculture industries and the campus-based research communities at the University of Illinois at Urbana-Champaign, Southern Illinois University-Carbondale, Illinois State University, and Western Illinois University. "Previously, individual groups and organizations went to the universities for resources separately," Gardner explains. "Hopefully, C-FAR can speak with a strong, unified voice to the research communities and to the budget makers in Springfield."

For additional information on C-FAR, call Leonard Gardner at (309)663-1144. — *Tina M. Prow and Terri Stone, Office of Agricultural Communications and Education*

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In the next issue:

Natural Resources and Environmental Sciences

An in-depth look at one of the College's new research emphases, including:

- *Systems and ecosystems approaches to research*
- *The new Department of Natural Resources and Environmental Sciences*
- *Systems-based resource management*
- *Interdisciplinary research teams and sustainable agriculture*
- *How consumer choices affect the environment*
- *The many levels of environmental awareness*
- *Barriers to adoption of sustainable agriculture methods*
- *Project Learning Tree*

Illinois Research

Agricultural Experiment Station
Spring/Summer 1994

Natural Resources and Environmental Sciences

A new look at resource management

College of Agriculture, University of Illinois at Urbana-Champaign, Volume 36, Numbers 1/2

The Cover

An aerial view of the landscape in east-central Illinois, where some of the richest soil in the state is found, shows a complex system of managed and natural ecosystems. A top challenge for agricultural researchers is to find ways to protect natural resources while keeping agricultural operations economically healthy. Photo by David Riecks.

Illinois Research

Spring/Summer 1994
Volume 36, Numbers 1/2

Published quarterly by the University of Illinois Agricultural Experiment Station

To receive a free subscription to *Illinois Research*, Illinois residents may write to the Editor, *Illinois Research*, Information Services, OACE, 47 Mumford Hall, 1301 West Gregory Drive, Urbana, IL 61801. Telephone: (217)333-4780. For bulk orders, write to the above address or call (217)333-2007.

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Directions

Systems Approach Addresses Societal Concerns

ROBERT J. REBER

This issue of *Illinois Research* emphasizes an important approach to managing our natural resources, one gaining momentum and credence as the College of Agriculture continues to examine life's basic interrelationships in an increasingly complex world. What is receiving much-needed attention is a systems-based approach that will guide researchers as they study questions crucial to solving world problems.

As you read through the articles in this issue, you'll notice topics highlighting collaborative efforts in the classroom, laboratory, and outreach programs. Many of these efforts are aimed at specific objectives and practical outcomes so the College of Agriculture can continue to aggressively meet the needs and desires of consumers. Also in this issue, we depart from our usual look at College research with a thought-provoking essay by Robert J. Reber, associate professor of nutrition. This essay provides a unique illustration of the interconnectedness between nature and humans and how we, as individuals, view that relationship.

Historically, we have conducted quality research that focused on traditional and relatively narrow areas of interest. This allowed agriculture to be highly productive, but it did not take into account the natural resource and environmental implications of agricultural production processes or technology.

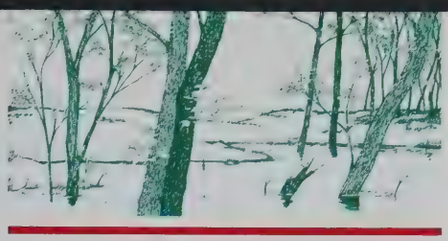
The success of this reductionist approach to science is best seen by the consumer in terms of abundant, reasonably priced food. Unfortunately, systems-level issues of environmental concern resulting from our production practices have not been adequately addressed and are unlikely to be addressed effectively without a shift in research emphasis. The Illinois Agricultural Experiment Station finds itself today in a situation where increasingly specialized scientists are at the forefront in our research programs, but interrelationships between many high-quality individual research efforts are often not researched or understood.

Our challenge, then, is to study and understand questions on the interface between disciplines so we can fill in key information gaps. Otherwise, we will not manage effectively at the systems level because environmental issues facing agriculture and natural-resources management are extremely complex and require an integration of the social, political, and biological dimensions. Initially we may find it difficult to work at the systems level because of our unfamiliarity with this approach as a result of the ever-increasing specialization of our scientists.

The systems approach allows for a unique look at issues facing society, such as negative impacts of agriculture on the environment and conservation of resources. By focusing inward from goals at the systems level, a different perspective is evident in how we view our agricultural production system. This should help us sharpen our agricultural processes and guide them toward systems-oriented goals.

Agriculture is changing. Considerably more attention must be directed toward environmental indicators at the systems, watershed, or landscape level so we can gauge progress in dealing with environmental issues. The articles you read in this issue will show you how the Agricultural Experiment Station is accepting this challenge and creating a new way of thinking and of seeing the world. — *Gary L. Rolfe, interim associate director, Illinois Agricultural Experiment Station, and head, Department of Forestry*

> *The significant problems we face cannot be solved at the same level of thinking we were at when we created them.*
>
> — Albert Einstein



A New Look for Natural Resources and Environmental Sciences

Anita Povich and Nancy A. Nichols

When Dean W.R. "Reg" Gomes recently announced his plans for restructuring the College of Agriculture, he parted from tradition by proposing, among other changes, the elimination of the departments of Agronomy, Forestry, Horticulture, and Plant Pathology and the Office of Agricultural Entomology. In their place, he proposed two new units, a Department of Crop Sciences and a Department of Natural Resources and Environmental Sciences (NRES).

Still under review by the UIUC Senate and campus administrators, the plan will offer new and innovative programs in research, teaching, and outreach that will clarify the College's thinking about the relationship between agriculture and the environment.

In talking with *Illinois Research* editors, Dean Gomes stated that the realignments will provide a basis for continued strength and greater opportunity to address emerging issues. He is quick to stress that reorganization is designed to help the College *better* address "those things that we have been addressing for a long time."

What's in a Name?

Under reorganization, which the faculty approved last December, even the name of the College will change. It will no longer be the College of Agriculture but, rather, the College of Agricultural, Consumer, and Environmental Sciences. The longer name reflects the complexity of natural and constructed systems into which agriculture fits.

According to Jeffrey O. Dawson, professor of forest biology and associate head of the Department of Forestry, "We're not abandoning our production emphasis but looking at increased efficiency of managing systems. You're more efficient if you minimize soil erosion because you cut down on future use of fertilizer and soil amendments....If you understand insects on a broader scale, you will be able to manage insects effectively at a lesser cost."

Gomes stresses the College's long history of stewardship. "We're about interacting with nature in an atmosphere that has increasingly been involved with the balance between productivity and natural resources. Our erosion work in this College goes back to the 1920s. We've been involved in the relationships between production of crops and the maintenance of natural resources for our entire history, back to when our doors opened in 1868."

The need for a systems approach has become increasingly apparent as the world becomes more complex, Gomes explains. He feels that institutions and organizations, when first formed, are relatively small, and their people tend to act and think broadly. He describes this broad approach as thinking about "the big picture, the direction they're trying to

BRIAN STAUFFER

Interdisciplinary research provided fuel for lively discussion between Bruce Hannon (left), UI professor of geography, and W.R. Gomes, dean of the College of Agriculture, at a recent Experiment Station retreat.

go, the missions they're trying to fulfill, the clients they're trying to serve, and the jobs they're trying to get done.

"We probably had been losing our ability to take a broad view at a time when more and more of the issues we're facing are more complex and require a look at the big picture."

Staying Ahead of the Curve

In the Dean's view, restructuring is all part of an effort to stay ahead of the curve. "If we can't be ahead, then we don't have any business doing research, addressing issues, and trying to solve problems. If we are solving only yesterday's problems, then we really aren't very important."

Dawson, chair of the transition team that is advising Gomes on the NRES department, says the new department will differ from any of the old units it replaces by being much bigger (fifty faculty members) and more diverse. He says the department will include most of the faculty concerned with urban ecosystem management — urban trees, turf systems, landscape and plant management — and the bulk of people working on environmental issues related to soil resources.

"Bringing these people together should increase collaboration between faculty formerly housed in separate units," Dawson says. "And some people believe that the name of the unit and grouping of individuals within the unit may strengthen the ability of faculty to compete for external research funding. [To a funding agency], it's not immediately apparent that a researcher in horticulture or soils might have an interest in environmental research.

"In my opinion," he explains, "one other thing that's unique about this department is that the faculty are engaged in research and teaching in dealing with a broad range of both managed and unmanaged ecosystems — everything from crop ecosystems to relatively pristine forest and prairie ecosystems. I see that as a good thing."

In the past, people in production-oriented units have focused on managed ecosystems to the exclusion of associated ecosystems. Dawson says, "This unit is better positioned to look at the broad spectrum of ecosystems and their interactions, and the landscape system as a whole. For example, management activities at the level of an agricultural field influence more than just that field. Fertilizers and chemicals may affect stream and groundwater quality.

"The influences of different land uses on regional wildlife populations might not be considered by those focusing on crop production, golf course management, or forest management for timber production."

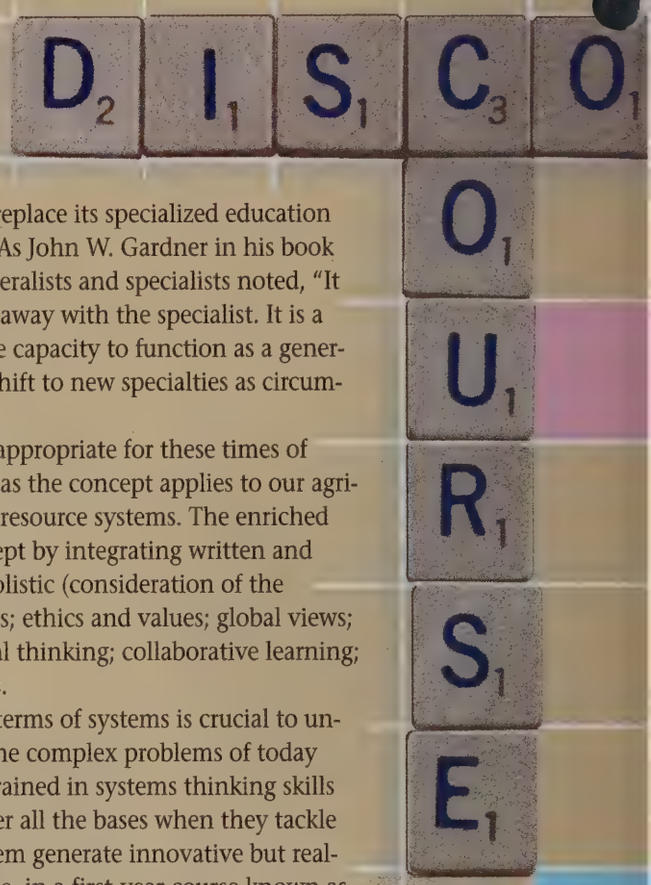
Dawson is enthusiastic about the challenge given to the eight members of the new department's transition team and believes "there's more likelihood that people will focus even more broadly on relationships between various ecosystems, how human activities in one area impact elsewhere."

Stirring It Up

In building a restructured College, Gomes hopes to "bring faculty with several kinds of specializations together so they can think about issues and changes that are

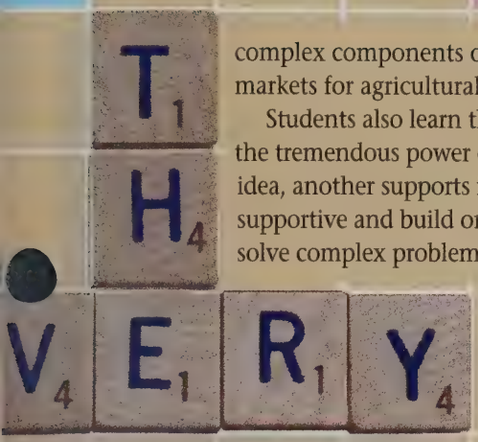
Since the mid-1980s, the UIUC College of Agriculture, led by the Office of Academic Programs, has revitalized its undergraduate programs with the goal of educating students to function in their future and to adapt to change. A grant from Higher Education Programs of CSRS-USDA has helped to implement these revitalization efforts.

The revitalization's theme is "Educating Students for Life in the Twenty-First Century." It strives for a balance between general education and specialized education through an enriched major that will produce more rounded, better-educated graduates. The College does not want to replace its specialized education with a general education. As John W. Gardner in his book *Self Renewal* (1963) on generalists and specialists noted, "It is not a question of doing away with the specialist. It is a question of retaining some capacity to function as a generalist, and the capacity to shift to new specialties as circumstances require."



Gardner's statement is appropriate for these times of rapid change, particularly as the concept applies to our agriculture, food, and natural resource systems. The enriched major addresses this concept by integrating written and verbal communication; holistic (consideration of the whole) systems approaches; ethics and values; global views; critical, creative, and visual thinking; collaborative learning; and problem-solving skills.

The ability to think in terms of systems is crucial to understanding and solving the complex problems of today and tomorrow. Students trained in systems thinking skills are better prepared to cover all the bases when they tackle problems, which helps them generate innovative but realistic solutions. For example, in a first-year course known as the "Discovery Course," students learn that visualizing complex problems helps them better understand these problems. Students "map" the



complex components of problems such as capturing global markets for agricultural products.

Students also learn that brainstorming procedures can harness the tremendous power of group thinking. One student suggests an idea, another supports it, another builds on it. When groups are supportive and build on group members' ideas, the potential to solve complex problems increases. Criticism is withheld in this stage of problem solving.

A further dimension of systems thinking involves the critical analysis of alternative solutions: Is a solution comprehensive? Realistic? No matter how exciting a possible solution might appear to students, they must learn that a solution means little unless it is complete and doable.

In the Discovery Course, students hear a lecture on systems thinking and complete a systems-thinking tutorial on the computer. In their discussion sections, they have an opportunity to practice their skills while talking about contemporary issues. In addition, instructors across the College weave more introduction and practice of systems skills into their existing courses. For example, instructors in introductory classes may use concept maps to display complex information or may have students make their own maps.

The systems approach to problem solving is employed in another course, "An Introduction to Agricultural Systems Analysis," developed by faculty in two different departments. This experimental course provides a focus for learning that will be useful throughout a student's formal and lifelong education. The approach takes values as well as beliefs into consideration and helps to raise the students' consciousness of the entire context of the problem situation, including the environment outside the system's boundary.

The curriculum project involves many faculty who have unselfishly dedicated their time and effort to help create a new generation of scientists, engineers, and related professionals who will have the education and expertise to address the challenges of the twenty-first century. — *William L. George, associate dean and director of academic programs and principal investigator of the USDA Institutional Challenge Grant on curricular revitalization; and John G. Schmitz, curriculum coordinator of the USDA Institutional Challenge Grant on curricular revitalization*

going to take place and be in a position to anticipate and address them as they come along.

"I like the idea of gathering talented people and throwing them into an atmosphere of ideas and foment, then seeing what they build out of it. It isn't necessarily relaxing, but it can be exciting. We have to make sure we talk about ideas and issues rather than people. But if we can bring people together to think about ideas, issues, opportunities, and problems to be solved, such groups could make this one of the most exciting places we have ever seen."

NRES activity gained momentum in 1990, when the Department of Forestry proposed to the College an undergraduate curriculum in natural resources and environmental sciences. Gomes credits the proposed curriculum with creating "a good deal of interest. There is demand for it." (See related interviews with NRES students, page 6.)

"The changing interests and changing emphases of the American people suggest that issues of natural resources and the environment *will* continue to have a more and more important role in decisions made about what we do and how we do it. And as that transpires, our people — with their history, their expertise, and their ability to see the big picture — will be important players in that growing area of decisions. So there is a new emphasis that will position us to take advantage of those opportunities.

The bottom line, says Gomes, is to stay ahead of the game — to keep looking forward in anticipation of society's future needs. "Wayne Gretzky, the hockey player, was asked once how he manages to be such a great hockey player. He answered, 'I go where the puck is going to be.' That sounds great, but how does he know where the puck is going to be?

"You know where the puck is going to be if you combine a lot of experience — Gretzky has seen the puck hit by everybody, bouncing off every wall, hitting every angle, and going at every speed. He combines this tremendous experience with what must be phenomenal reflexes, athletic skill, and — most important — the mental ability to get out ahead of the puck.

"You can't always chase what is going on; you have to be positioned where the action is going to happen. You might look awfully foolish when you head one way and the puck goes another. But if you're willing to look foolish occasionally, most of the time you can be ahead of the puck."

Gomes is quick to point out the difference between a trend and a long-term concern. "There's no question that environmentalism has a faddish component. We have to be careful that the things we do and the things we're trying to accomplish don't get caught up in those fads. At the same time, however, it is obvious that concern for the environment and our natural resources is going to be a very important part of our society. To one degree or another this has been so for a very long time. And there's no question it will continue to be for a long time to come."

Anita Povich, communications specialist, Department of Forestry and Agricultural Experiment Station, and Nancy A. Nichols, editor, Office of Agricultural Communications and Education

Studying Tomorrow's Topics Today

Anita Povich

While College researchers are still gearing up for increased systems-based research, nearly 200 students in the College have chosen to study within the proposed curriculum of natural resources and environmental sciences in the past four years.

One such student is Theresa L. Smith, from Chillicothe in central Illinois. While majoring in English at the University of Illinois, Smith took an elective course in forestry that delivered a strong message — her actions affect the environment.

"Change of lifestyle is the key here," she relates, recalling "EarthCare," the Forestry 199 class that introduced her to basic ecology, recycling, population density, global warming, the rain forest, and the ozone level. "I really enjoyed the topics; many were new to me, even though I was previously aware of environmental concerns."

Before she took the course, Smith planned to get a teaching certificate and work in editing or advertising. After graduating in 1992 with a bachelor's degree in English, however, she was inspired to continue academic studies in forestry so she could specialize in environmental education.

"I became interested in the environment and educating others to help us all live more sustainable lifestyles," she explains.

Although it is fairly common for students to change majors or shift direction in their career choices, Smith's studies are somewhat unusual in that she was able to shape her own graduate curriculum, working with forestry and College of Education advisers.

"The College of Agriculture gave me the freedom and opportunity to choose a diverse program. I could have specialized in environmental education in other campus units, but agriculture gave me a hard science background and my education courses gave me methodology."

As a research assistant, Smith was a team member on a major project that helped define her thesis. Working with a

David Ricks

Theresa Smith, an environmental education major, shares her enjoyment of nature with 5-year-old Adrienne Weber at the Anita Purves Nature Center in Urbana.

state coordinator for Project Learning Tree (see related sidebar on page 8), she helped create a network of Project Learning Tree users in Illinois schools, scheduling workshops and presentations and creating supplemental teaching materials and resource information guides.

"After working with various educators in the PLT project, I became interested in how environmental education was being approached in K–12 public schools." Last May, Smith completed a survey of 500 K–12 teachers to determine the levels of environmental literacy and environmental education activities in Illinois public schools. She presented her results in a public address to the Illinois State Board of Education in Springfield this past June.

Smith feels her studies definitely fit into the College of Agriculture because of "the College emphasis on natural resources and how to use them in a more sustainable manner. The College's proposed mission statement emphasizes and reinforces this idea," she says, citing the enhancement of life in rural and urban environments by creating systems involved with food, fiber, consumers, and the environment.

In keeping with this approach, in the past two years Smith volunteered as a school tours leader with Anita Purves Nature Center in Urbana and earned academic recognition from two honor societies, Gamma Sigma Delta and Xi Sigma Pi. Her varied interests are seen in memberships in the Soil and Water Conservation Society, Society of American Foresters, Environmental Education Association of Illinois, and North American Association of Environmental Education.

Grass-Roots Training

Another student who has decided to take advantage of the proposed natural resources curriculum is Karyn McDermaid, from Streator in northern Illinois. Tossing her hat into the political arena is a definite possibility for McDermaid, who plans to do something practical and effective with her interests in the environment.

"I see myself five years from now in the decision-making arena," she explains, "combining social, political, and hard sciences into effective environmental and natural resources policy. Eventually, I would like to be known as a 'mover and shaker,' a person who makes decisions and gets things done."

If McDermaid succeeds in her endeavors, it will be because she sees what she terms "the big picture," something she learned in her forestry studies. "Everything we do affects something else," she states. "No decision is cut and dry; there is always a much larger interrelated biological, social, and political system to consider."

She originally came to the University of Illinois to major in agricultural economics because of her marketing interests.

"I became interested in grass-roots movements, letter-writing campaigns, and petitions after working for the federal credit union in Streator," she says. "I ran their mainframe and was responsible for the marketing program. This was my first experience with effective public involvement efforts. I also initiated methods to conserve and recycle the vast amount of computer paper we used."

After an introductory UI course in environmental sciences, however, she switched her specialization from marketing to environmental and resource economics. "I looked at new options," McDermaid explains, "choosing my undergraduate electives to match the College's proposed curriculum in natural resources and environmental sciences. I realized I wanted to learn more about this subject during my senior year and began to consider graduate school.

"But I was interested in broad, vague things," she explains, "not a set curriculum."

After graduating with high honors, including Dean's List, McDermaid, a member of Alpha Zeta, a national honors fraternity, entered graduate school in forestry "because the Forestry Department was flexible enough for me to tailor my program and integrate my interests. There's a need for people like me who are generalists and big-picture people, capable of bridging interdisciplinary gaps."

McDermaid filled her undergraduate course work with interests in social sciences, the environment, and law. She is using her graduate studies to beef up on physical and biological sciences, something she sees as necessary if she hopes to

DAVID RIECKS

Karyn McDermaid hopes to toss her hat into the political arena — in the area of environmental and natural resources policy.

someday make effective policy after graduating in May 1995.

Her graduate research finds her working with the Conservation Congress of the Illinois Department of Conservation, described as a "big initiative to get constituency involvement into their management and policy decisions."

Although she never expected to find herself in the College of Agriculture — "at one time I thought ag was only production agriculture" — she strongly believes the College's emphasis on natural resources and environmental sciences is appropriate and reflects agriculture's increased concern with broad and changing societal goals.

"Agriculture is not only dependent upon our natural resources but also has a tremendous impact on them," she explains. "The moving trend toward the adoption of ecosystem-based management will demand a more holistic approach to all land management decisions, including production agriculture. It is an exciting time for agriculture to meet the challenge and begin to consider all biological impacts on the greater landscape while integrating social goals and values and political agendas into agricultural decisions.

"But this needs an integrated effort from all colleges on campus to include natural resources and environmental sciences education in the curriculums," she explains. "Through progressive educational objectives, aggressive public policy, and political action, we can improve and preserve our natural environment for future generations," this future strategist reaffirms. "But education is the key."

Work Can Be Fun

For outdoor lover Mary Kathryn Lowry, who grew up in Chicago's suburban Naperville, a career in the natural resources area didn't seem like "a real job." After beginning her University of Illinois studies in animal sciences with plans to become a veterinarian, she switched to forestry when she discovered its many possibilities, including the chance to be outdoors.

When she graduates this spring with a master's in forest science, she plans to work with private forest landowners. Her path from animals to trees began when she chose an undergraduate forestry elective over a food science course.

"That got me hooked," she recalls. "I planned to be a veterinarian because I always loved horses. But I changed my major to forestry because it was fun, I've always been an outdoor person, and I didn't realize forestry was so varied."

Lowry's forestry undergraduate adviser helped her plan her studies and find student employment that offered a variety of experiences. After working with a forestry geneticist, for example, she learned she preferred working outdoors to washing glassware in a laboratory.

During her summer breaks, she planted and watered flowers for the Lisle Park District in northern Illinois, marked trees with Dutch Elm disease for the Cook County Forest Preserve, and helped plant about 12,000 trees for the Champaign County Forest Preserve District's reforestation efforts.

She discovered a special interest during her junior and senior years when she helped collect and enter data for a landowner survey. The project introduced Lowry to hardwood management, forest stewardship, and working with people — three things she especially enjoys.

As an undergraduate, Lowry joined the Society of American Foresters, held offices in the Illini Riding club and Illini Foresters, and edited *The Railsplitter*, a forestry yearbook. After receiving her bachelor's degree, she worked as a technician for the Soil Conservation Service's National Resource Inventory, then joined the Illinois CARE program (Continuing Assistance and Resource Education), writing stewardship plans for landowners.

She returned to graduate school in 1993, remaining in agriculture because "the College gave me a little place in a big school. They know who I am — I'm not just a number. I like the freedom and opportunity I've had in ag," she explains, "working in the field all summer, conducting inventories, and writing plans.

"Management of our natural resources is becoming more important as we face a variety of problems — concern for endangered species; threatened ecosystem

Project Learning Tree

A Window for Learning about the Environment

Many discussions about the environment seem to focus on the issue of trees — old-growth forests and clearcutting come to mind. In listening to these discussions, one quickly ascertains that few people present the issue from an unbiased perspective. Regarding the economics of old-growth forests, for example, an environmentalist might say that eliminating the cutting of old-growth in the Pacific Northwest would cost 4,000 jobs, whereas a representative from the forest-products industry might put the number at more than 65,000 lost jobs.

In today's world, it is unfortunate that so many people examine trees and environmental issues in such a polar manner. There is a need for greater understanding of these important topics.

To help improve people's awareness and understanding of the environment, Project Learning Tree (PLT) was established in 1973 through a partnership between the American Forest Institute and the Western Regional Environmental Education Council. Now a national program, PLT uses the forest as a "window" to see into natural and built environments, helping young people gain an awareness and knowledge of the world around them as well as their place within it.

The PLT environmental education program is designed for teachers and other educators working with students in pre-kindergarten through grade 12. PLT helps prepare students to make wise decisions about conservation practices and resource use.

David Recks

Schoolchildren develop a better understanding of the natural world through environmental education programs targeted at their age group.

Features

PLT is broad in scope:

- PLT is a comprehensive environmental curriculum. It encompasses the total environment — land, air, and water. It is local, national, and global in scope.
- PLT activities are action-oriented, can be used in any order, and require little, if any, equipment.
- PLT focuses on developing critical-thinking skills. It does not seek to teach children *what* to think about the environment but, rather, teaches them *how* to think about the environment.
- PLT activities incorporate important environmental lessons into all areas of the curriculum. They can be infused into science, language arts, social studies, reading, arithmetic, art, music, civics, and other areas.
- PLT can be applied in many different educational contexts, from classrooms, to nature centers, to museums, to scout troops.
- PLT provides ready-made lessons and activities that can be incorporated into busy classroom schedules. The curriculum is "classroom friendly," requires minimal preparation, and, according to teachers and students, is fun to use.
- PLT's curriculum includes role-playing exercises that echo the real decisions that are being made in the students' communities.

Mission

The program aims to:

- Increase students' understanding of our environment.
- Stimulate students' critical and creative thinking.
- Develop students' ability to make informed decisions on environmental issues.
- Instill in students the confidence and commitment to take responsible action on behalf of the environment.

Educational Themes

The following themes run throughout PLT:

- Diversity — demonstrating a wide array of habitats, societies, technologies, and cultures.
- Interrelationships — highlighting ecological, technological, and social-cultural systems as interactive and interdependent.
- Systems — teaching how environmental, technical, and social systems are interconnected.
- Structure and scale — demonstrating how technologies, societal institutions, and components of natural and human-built environments vary.
- Patterns of change — showing how structures and systems change over time.

Goals

The bottom line of the project is to:

- Create awareness, appreciation, understanding, skills, and commitment to address environmental issues.
- Provide a framework for students to apply scientific processes and higher-order thinking skills to solve environmental problems.
- Increase appreciation for and tolerance of diverse viewpoints on environmental issues by developing attitudes and actions based on analysis and evaluation of the available information.
- Stimulate creativity, originality, and flexibility to resolve environmental problems.
- Encourage students to become responsible, productive, and participatory members of society.

For additional information on Project Learning Tree, contact:
T.J. Jacob, Director of Holistic Environmental Education, Department of Forestry, University of Illinois at Urbana-Champaign, W521 Turner Hall, 1102 S. Goodwin Avenue, Urbana, IL 61801, (217)333-2770, (217)244-3219 (fax), pofearth@ux1.cso.uiuc.edu (e-mail).

DAVID RICCKS

Her plans to be a consultant for private forest landowners will give Mary Lowry a chance to combine three things she especially enjoys — hardwood management, forest stewardship, and working with people.

types, such as old-growth forests; and continuing demand for forest products. People are much more aware of our resources and the possible conflicts related to their uses. Agriculture gives me a broad background so I can appreciate the diversity found in our natural resources. In addition to recreation and wildlife habitat, I'm looking at plants, soils, and crop management."

Lowry cites the freedom inherent in her studies. Although working outdoors gives her one type of freedom, selecting and shaping her specialization to learn a broader view gives her another freedom as well.

"I'm able to work on many different things rather than specialize," she states. "For example, I'm looking at jobs in resource conservation and development, and jobs in state divisions of forestry.

She believes the College emphasis on natural resources will enhance agriculture and the UI campus if successful. "It needs to carry over to other disciplines as well," she says, "because everything is linked to natural resources. Everyone on this campus should learn that we all live on Earth and use what it produces.

"We need to learn these ideas because what we see and hear in the media are not necessarily accurate. Our resources can be managed. Before I studied forestry and natural resources, I would fish, walk in woods, ride my horse, and have fun. I never thought that resources were finite and needed to be managed so they wouldn't get used up. We need to learn the whole truth about our natural resources. That's why I like the idea of educating landowners and teaching people about managing their natural resources."

Lowry recently talked with elementary schoolchildren about careers in natural resources and environmental sciences. In response to their surprise that women work in forestry, she explained, "it's a good field for women as well as men. You can have fun working outdoors and still get paid," she smiled.

Anita Povich, communications specialist, Department of Forestry and Agricultural Experiment Station

Urban Public Housing Residents and the Power of Trees

W.C. Sullivan and F.E. Kuo

Imagine the lives of two single mothers, Maria and LaTisha. Both women live in Chicago public housing, in a development called ABLA located just west of the University of Illinois at Chicago. Maria has two children, a 3-year-old boy and a 1-year-old girl. LaTisha has two girls, ages 1 and 4. Both women are unemployed, and each has lived in ABLA for more than two years.

Against this background, consider that Maria is having difficulty managing the challenges of living in poverty. Life for Maria seems overwhelming — she feels strained and finds she is easily distracted and prone to error. She's been irritable with the couple of close friends on whom she depends most. Perhaps of most concern, she's having difficulty planning and carrying out previously made plans.

LaTisha, on the other hand, is doing somewhat better. Although she feels the strains of living in poverty, she reports that she feels up to the challenge. She plans to take a class on nutrition offered by the Cooperative Extension Service and indicates she is getting to know and trust her neighbors.

Maria and LaTisha live in "Family Housing" at ABLA. While the architectural style of Maria's and LaTisha's apartments are identical, the landscape surrounding their homes is considerably different. Maria lives in a veritable urban desert, surrounded by a vast amount of pavement, with few trees nearby. Outside LaTisha's home, there are a number of trees, some grass, and even a small garden.

Maria is having a harder time coping with poverty than LaTisha is. Does living near trees make that kind of difference? There are reasons to think so, we're finding out.

Is There a Connection Between Trees and Coping?

Research has shown that exposure to urban environments can have decidedly negative effects on people's functioning. The effects are similar to the way Maria feels and often include becoming error-prone and easily distracted; feeling strained and irritable; being inclined to make risky choices; being less likely than usual to help someone in distress; having difficulty either planning or carrying out previously made plans. These are all symptoms of one psychological condition — *mental fatigue,* a state that makes being effective quite difficult.

In contrast, environments that contain trees, grass, and other natural elements have been shown to have healing, positive effects on functioning. In recent studies carried out at the crossroads of several disciplines (horticulture, psychology, landscape architecture, urban planning, nursing), scientists are examining the relationship between people and nature. The findings are significant not only because they show how important nature is to humans but also because they suggest ways in which hassled individuals might use nature to restore themselves to healthy and effective functioning.

Consider a few examples:

- In a study that involved women during the three months immediately after surgery for breast cancer, University of Michigan researcher Bernadine Cimprich found that women who participated in normal post-operative activities had uneven, inconsistent recovery of mental functioning. Women who participated three times per week in simple outdoor experiences, however, showed consistent improvement in their ability to concentrate, pay attention, and take on new challenges.

- Clinical psychologist Lisa Canin found that in a group of people susceptible to burnout — people who care for patients with AIDS — those who regularly engaged in quiet, "green" activities were able to sustain robust functioning. The AIDS caregivers who did not participate in "green" activities were significantly more likely to feel overwhelmed, hopeless, and worn down.

Arnold Stellema

How urban nature affects people is the subject of research at the UI Human Environment Research Lab.

• Environmental designer Carolyn Gilker found that University of Wisconsin students living in dormitory rooms with a view of nature showed measurably higher levels of mental functioning than their peers whose view was of other buildings or parking lots.

Contact with nature (for instance, a walk among trees or a window view of trees) produces consistent, measurable reductions in mental fatigue. Several studies have shown that after exposure to nature, mentally fatigued individuals show improved mental functioning; have a sense that things are manageable and that they can cope; and gain a willingness to persist in the face of difficulty.

Our work, like the work in these examples, involves understanding how and why trees and other natural elements support human functioning. This work takes place on a relatively undramatic, even small, scale. We are not investigating the effects of large tracts of wilderness on human functioning. Our focus, instead, is on accessible nature — trees that are visible through windows, that shade porches, that line streets and grow in back yards. This work examines the effects of nearby nature — the kind of nature found in cities — on human functioning. Our work asks, can contact with nature provide similar benefits to residents of urban public housing?

Why Study Residents of Urban Public Housing?

One reason to study the connection between trees and coping in urban public housing is that individuals residing in such housing may be especially prone to mental fatigue. There are considerable demands associated with living in poverty. In addition, there are environmental demands placed on residents of large public housing complexes, including crowding, constant activities, noise, the threat of violence. The combination of poverty and a difficult environment may make mental fatigue severe and chronic in individuals living in urban public housing.

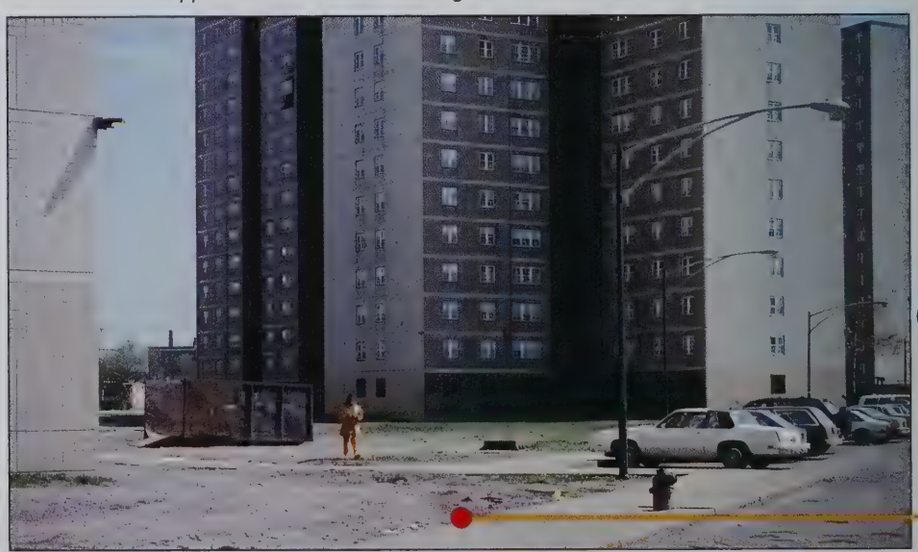
Another reason is that the consequences of mental fatigue may be especially far-reaching for individuals struggling to work their way out of poverty. Think of Maria, for instance. In her mentally fatigued condition, she is unlikely to expend the effort necessary for planning and other future-oriented lines of thought. If she were to look for a job, it is not hard to imagine that her impaired mental performance and unwillingness to persist would hamper her efforts to find a job. Mentally fatigued individuals are unlikely to generate creative solutions to the problems they face. (In teenagers, mental fatigue may lead to decreased persistence and performance in school, falling behind, and ultimately dropping out.) Mental fatigue also has consequences for social behavior and functioning. Maria's persistent irritability and the sense of strain brought on by chronic mental fatigue threaten the very social support networks that might have helped her cope — leading to more fatigue and more social strain, in a vicious cycle.

Finally, it is compelling to investigate these issues in Chicago Housing Authority developments because the buildings vary considerably in the amount of nearby nature available to residents. This variability allows us to make systematic comparisons between individuals who live in the same style of building in order to assess the difference nearby nature makes.

The U.S. Forest Service's National Urban and Community Forestry Advisory Council is supporting a comprehensive investigation of the value of nature for people who live in urban public housing. Our research group, the Human-Environment Research Laboratory, is carrying out this investigation in three Chicago

PHOTOS: BILL SULLIVAN

Compare these four scenes. The photos were taken at the Chicago Housing Authority's ABLA development (top left and right) and Robert Taylor Homes (bottom left and right). Are settings with trees more supportive of human functioning?



Housing Authority developments — the Robert Taylor Homes, Ida B. Wells, and ABLA. Our research addresses the difference that trees, grass, and other natural elements make in the functioning of public housing residents struggling to cope with poverty.

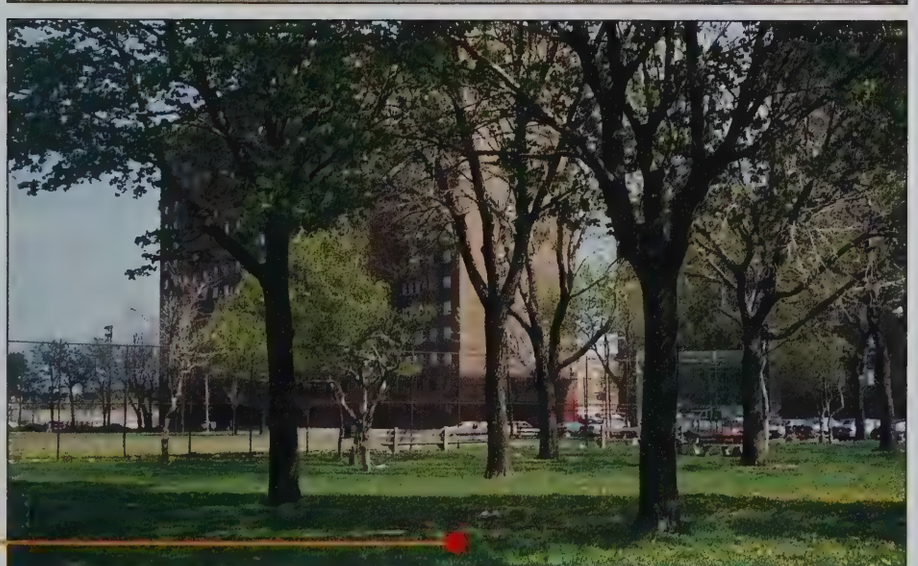
Our Approach to these Questions

Our approach to these questions is multidisciplinary — it takes advantage of theories, methods, and individuals from psychology, horticulture, landscape architecture, and a host of other disciplines. We have developed three research teams, each of which focuses on a different aspect of the relationship between people and nature.

The *Adult Functioning Team* consists of researchers from three disciplines — environmental psychology, horticulture, and landscape architecture. This team is studying the impacts of urban nature on adult functioning. Are residents who have a view of trees more successful in their day-to-day functioning? Are they more creative, more persistent, more effective, in tasks ranging from organizing and planning their lives to finding a job? Do they have the energy to make important decisions with the care and thought these decisions deserve?

The *Social Support Team* consists of researchers from social psychology, environmental psychology, and landscape architecture. This team is studying the impacts of urban nature on residents' social behavior and functioning. Do residents who have more contact with nature resolve conflicts with more patience, with more success — are they less prone to impulsive violence when their patience is stretched to the limit? Do they have the energy to maintain the social networks so critical in coping with difficult life events and situations? This team compares the strength and health of such social support networks in areas rich in and impoverished in urban nature.

The *Child Development Team* is composed of researchers from developmental psychology, leisure studies, and horticulture. This team is examining the impacts of urban nature on child development. Do children who live in a more supportive environment function better in school? Do children living in urban public housing experience chronic mental fatigue? If so, does this fatigue contribute to low scholastic achievement scores and high rates of absenteeism? Does the irritability associated with mental fatigue contribute to aggressive or destructive behavior in children?



What Difference Will This Research Make?

In times of tight budgets, public officials look to reduce costs, and in doing so it is reasonable that they eliminate amenities. But are urban trees mere amenities? Is nearby nature simply a pleasantry? Or do trees play an essential role in human functioning?

Maria and LaTisha live under similar circumstances, yet their lives vary in what might be a critical respect. LaTisha lives in a setting that may help restore her capacity to function effectively. Our hypothesis is that nearby nature contributes to LaTisha's capacity to manage her life, maintain social ties, and persist at difficult tasks. If trees have this power, then clearly they are not amenities but critical components of healthy, supportive urban environments.

W.C. Sullivan, assistant professor of horticulture and landscape architecture, and F.E. Kuo, postdoctoral research associate in environment and behavior, Department of Horticulture

Systems-based Management

Richard E. Warner and Gary L. Rolfe

The astronomer looks high, the geologist low. Who looks on the surface of the earth? The farmer, I suppose, but too often he sees only grain, and that only of the mere bread-bushel-and-price side of it.

— John Muir

Nearly a century ago, naturalist John Muir observed that too often we compartmentalize our knowledge of agriculture and the natural world and limit our ability to understand and appropriately manage land and related resources. Muir's comments point to the need for crossing the boundaries of traditional disciplines, a need that's increasingly relevant as we face the challenges of a burgeoning human population, the associated depletion of resources, and increasing environmental problems.

These challenges will require complex management strategies that draw upon many disciplines if we hope to meet society's needs while minimizing the alteration of critical ecosystem processes vital to sustaining our environment. We define these cooperative, highly integrated research and management efforts as *systems approaches* to problem solving; they exist at the interface between many facets of knowledge (disciplines).

Five Limiting Factors

For various reasons, truly integrated attempts to address problems in land and resource management at the systems level have been extremely limited. First, although perspectives such as John Muir's have persisted through the decades, only recently have we seen a need for wide recognition of systems approaches. Second, the familiar reductionist method of scientific inquiry has produced dramatic results in the development of knowledge along disciplinary lines. The improvement of crop yields, for example, is a classic example of how agronomists have built on previous knowledge and, over time, improved our ability to understand and manipulate plants and their growing environment.

The success of reductionist thinking is well documented and remarkable. Consequently, scientists are hesitant to move away from narrowly focused research, which allows for carefully manipulated experiments, to begin the study of systems and their complex array of interrelated factors, many of which defy experimental intervention.

Third, as the knowledge base has proliferated, many scientists have become carefully focused specialists in order to master their discipline. Even within agriculture, many scientists share little of the same terminology with their colleagues.

Fourth, an emphasis on systems-level thinking contradicts traditional approaches for educating, evaluating, and rewarding scientists. Institutions typically recognize and reward an individual for efficiently producing reliable knowledge in his or her discipline, a process most compatible with using the reductionist approach in a narrow conceptual domain.

Fifth, only recently has the science of ecology adequately provided the base for systems-level understanding, and complex computer technology the capability of integrating the vast array of information required for systems-level management.

Brian Stauffer

Stephen Tondini (left), Rachel Mendoza, and Danilo Chinea from the UI Department of Forestry know the value of a team approach to solving complex systems-level problems.

Taking Time for Teamwork

By contrast, systems approaches require team efforts and, given tradition, investigators involved in such efforts typically perceive considerable risk in bringing such research to fruition. These perceived risks come from several directions. For example, team efforts require intensive planning, coordination, and communication, optimally including the upfront involvement of the various segments of society that are expected to deliver and/or use the research products. Such group efforts do not come with a guarantee of success, and they can be very time-consuming. Moreover, determining how complex factors function at a systems level frequently requires that scientists work together to gather intensive observations over prolonged periods of time and may require replication of studies in several regions. Also, systems can seem like moving targets because whatever the focus of study, there are always factors outside of the focus that are also important. Thus, systems research tends to be complex and costly while lacking the extensive funding base associated with research in more traditionally defined areas.

The study of ecology is noteworthy because it is closely aligned with systems research; ecosystem processes include the overwhelming complexity of interrelated biotic and abiotic factors. Furthermore, ecology and systems research do not have the foundation of comprehensive, unifying theories that are common for many narrowly defined disciplines. However, applied ecology has thus far not addressed many of the systems-level questions essential to society and agriculture. Much of the ecological theory has been based on the study of relatively undisturbed environments — far removed from agriculture — and the applicability of such concepts to broader systems questions is in many respects unknown. Thus, although research methodologies used in ecology are germane to systems research, systems research in land-based resources encompasses more than ecology and requires entirely new applications of theory to practice.

Reducing Spray Drift Helps the Environment

Spray drift is a major concern because off-target deposits of chemicals can injure susceptible vegetation, damage wildlife, and contaminate water supplies. Costly problems can result when carelessly applied pesticides — especially herbicides — drift and cause damage to economically or aesthetically important crops.

The amount of particle drift depends mainly on the number of small "driftable" particles produced by the nozzle. Although excellent coverage can be achieved with extremely small droplets, decreased deposition and increased drift potential limit the minimum size that will provide effective weed control.

Techniques used when applying pesticides greatly determine the amount of spray drift that occurs. The type of nozzle, pressure, height, and spray volume all affect the off-target movement. The ability to reduce drift is no better than the weakest component in the spraying procedure.

The potential for drift must be considered when selecting a nozzle type. Nozzles that produce larger, less driftable droplets are preferred. In general, low-pressure sprayers produce larger droplets than high-pressure sprayers.

Spray height is another important factor in reducing drift losses. Drift can be reduced by spraying closer to the ground. Correct spray height for each nozzle type is determined by nozzle spacing and spray angle.

Using larger nozzle sizes also minimizes drift. Increasing the spray volume by using higher capacity spray tips results in larger droplets that are less likely to move off target. The only effective means of reducing drift by increasing spray volume is to increase the nozzle size.

Weather conditions that can have a major impact on the amount of drift include wind speed and direction, temperature, relative humidity, and atmospheric stability. Wind speed is usually the most critical factor of all meteorological conditions affecting drift. The greater the wind speed, the farther off target small droplets will be carried.

Determining the wind direction relative to sensitive crops is important. Leaving a buffer zone at the downwind edge of a spray area greatly reduces damage to sensitive plants.

One of the best tools available for minimizing drift damage is the use of drift-control additives to increase the spray droplet size. Tests indicate that downwind drift deposits are reduced from 50 to 80 percent with the use of drift-control additives. A number of additives are commercially available, but they must be mixed and applied according to label directions in order to be effective. They do not eliminate drift, however, and common sense must still remain the primary factor in reducing drift damage. — *Loren Bode, professor, Department of Agricultural Engineering*

Research and Ideas Come Together

How does a land-grant institution such as the University of Illinois stimulate more systems approaches among students and faculty? To better respond to the needs and desires of consumers of agricultural products and services, College of Agriculture researchers are exploring new potentials for collaborative research that might cross specialty, departmental, college, and university lines. There are now deliberate efforts under way in teaching, extension, and research. The Illinois Agricultural Experiment Station has developed a series of special research initiatives to encourage faculty to work in teams to address systems topics that have received little research attention. A special two-day retreat was held in May of 1994 that brought together nearly forty researchers who focused on team approaches to systems-based resource management and brainstormed a number of innovative proposal ideas.

The first IAES systems research initiative under way asks faculty to consider a watershed in an Illinois landscape as the appropriate regional setting. The region will include communities, individual farms, and a variety of agricultural production systems in addition to soil, air, water, plants, and animals, all of which will interact with humans and their settlements. Investigators are encouraged to focus on the long-term sustainability of the system, such as the appropriate mix of resource utilization for that watershed. This could include not only farming practices and their relationships to the area's resources but also the relationship between farming and resource management practices and the needs and perceptions of humans in that watershed.

For example, current land-use practices may be modified to enhance or protect natural components of the system and

Given the tendency toward increasing specialization among scientists, the College is making a special effort to foster systems thinking.

Water. Protecting It for

Sidedressing nitrogen is a good-neighbor practice for producers farming in watersheds where communities get their drinking water primarily from surface supplies, according to preliminary results from recent UI research. Farmers typically sidedress nitrogen after planting, when the crop is ready to use it. The timing allows farmers to use less nitrogen. Less product and greater intake by the crop reduce the potential for nitrogen movement to groundwater or surface water.

"We've found that a difference in management practices can make a difference in nitrate level being supplied to the river from tile drainage," says Kent Mitchell, a UI agricultural engineer. Mitchell is part of a research team monitoring the Little Vermilion River. The rivers stretches through the southern end of Vermilion County in east-central Illinois.

Researchers are monitoring the river, drainage tiles, and Georgetown Lake for concentrations and fluctuations in the levels of nitrate, some pesticides, and sediment. The researchers are also are looking for ways to improve water quality. For instance, grass buffer strips and constructed wetlands added to the project last year are expected to help researchers determine how farmers might best use these "filters" in their fields to keep sediment, fertilizers, and farm chemicals out of the water.

Preliminary data already show that a sidedress nitrogen application has an advantage over preplant for reducing nitrate levels, Mitchell said. Two years of monitoring data collected from water discharged by subsurface drainage tiles show an average of 17.7 parts per million (ppm) nitrate-nitrogen from fields with preplant nitrogen application management, well above the Environmental Protection Agency drinking water standard of 10 ppm. During the same years, researchers measured an average 9.7 ppm nitrate-nitrogen in subsurface drainage tiles from fields where nitrogen was sidedressed.

These drainage tiles carry groundwater into the Little Vermilion River, which empties into Georgetown Lake (also in Vermilion County) and other lakes used for community drinking water. "From the tile line, farmers could cut nitrate-nitrogen concentrations nearly in half," Mitchell figures. "If they reduce nitrate-nitrogen entering the river by 8 ppm, the nitrate-nitrogen level should be well below 10 ppm in the water supply.

"Nitrate removal by water treatment is expensive, as is blending to reduce nitrate-nitrogen levels," he adds. "The data are preliminary, but the results we have now indicate nitrate-nitrogen levels in Georgetown Lake could be reduced below the EPA threshold if many farmers in the watershed could alter their nitrogen application methods."

David Riecks

Georgetown Lake, created by a dam on the Li in east-central Illinois. Researchers are looking

arms and Families in Illinois

The tie between nitrate in the water and nitrogen applications on the farm appears in other monitoring data collected from the Little Vermilion River and Georgetown Lake. Data show nitrate levels frequently exceed EPA drinking water standards from March through June, when farmers make spring nitrogen applications, and start to drop below the standard by July, as the corn crop begins to draw on nutrients.

These seasonal surges, along with the tile monitoring data, provide additional support to the idea that nitrate in water might be reduced through sidedress application, Mitchell suggests.

This project is a cooperative effort of researchers with the Illinois Agricultural Experiment Station, Cooperative Extension Service, Soil Conservation Service, and Agricultural Stabilization and Conservation Service. Funded in part through the Illinois Groundwater Consortium in 1990, the project is slated to end in 1995. One possible next step for researchers is to take the results and use them in a watershed model to predict changes in water quality from management practices on individual fields. — *Tina M. Prow, science writer, Agricultural Experiment Station*

ermilion River, supplies drinking water to the more than 4,000 residents of Georgetown ays to keep sediment, fertilizers, and chemicals out of the water.

ensure long-term productivity of soils, plants, and animals. The long-term relationship of altered land-use practices and the economic well-being of farmers and rural communities will also be considered. Likewise, the ethical responsibilities of land managers (farmers and landowners) and the broader population of Illinois affect the system and appropriate management strategies. The collective overview brought about by this effort will allow College faculty to contribute their expertise within a team context, in order to address the broader systems-level questions facing society.

The emphasis on systems in the College of Agriculture will not supersede the efforts of carefully focused faculty who are advancing knowledge using reductionist science. Rather, the systems emphasis will build on this critical base. However, given the tendency toward increasing specialization, the College is making a special effort to foster systems thinking. The IAES special research initiative is an example of an incentive for faculty to work together in new ways to address systems needs and to leverage additional funding for such projects in the future.

Scientists Are Adapting to New Needs

Many of the faculty featured in this issue of *Illinois Research* are becoming experienced in working at the interface of different types of knowledge. In the future, we will see a role for scientists who specialize in working at this interface — their ability to acquire and use systems knowledge will enhance our problem-solving ability for issues facing society, ultimately benefiting the teaching and outreach functions of the College.

This coordinated interplay of systems-level approaches, building on our solid base of reductionist experiments, is essential if we are to meet the world demand for food while protecting our critical resources.

Richard E. Warner, interim assistant director for natural resources, Agricultural Experiment Station, and Gary L. Rolfe, interim associate director, Agricultural Experiment Station, and head, Department of Forestry

Sustainable Ag Projects Bring Researchers to the Farm

Tina M. Prow

Curiosity is bringing researchers and producers together for three projects that explore different facets of sustainable systems of agriculture. The collaboration allows for a blending of expertise and experience.

"We've got the equipment, we've got the land, and we've got the questions. I'd like to see more research on sustainable systems conducted on more farms. It's a lot more valuable to me than most research," said Terry Holsapple of Greenup, Illinois. Holsapple farms 450 acres with his father and has farmed his own 120 acres organically for the past five years. His farm is devoted primarily to corn and soybeans, but he has grown some fourteen different crops for sale over the years, including alfalfa, wheat, oats, and a variety of vegetables. He also plants rye and hairy vetch as cover crops. Although Holsapple harvests and sells seed from the hairy vetch, the cover crops are grown primarily to reduce soil erosion during the winter and spring. Hairy vetch also adds nitrogen to the soil.

BRIAN STAUFFER

Cooperative on-farm research is uncovering new information on the value of crops such as hairy vetch, which reduces erosion and adds nitrogen to the soil.

Holsapple, Tom Horton of Albion, and Mark Cender of Fisher provided acreage for University of Illinois agronomist Donald Bullock to carry out a three-year study of hairy vetch and rye used as winter cover crops in corn to soybean rotations. The location of the farms in central, southern, and northern Illinois, respectively, show how cover crops perform in different regions of the state. Each farmer provided 10 to 12 acres, a larger acreage than UI research farms could commit to a single study. In addition, the farmers asked questions and offered insights that helped shape the study.

"These cooperating farmers were interested in improving efficiency and profit. They are environmentally conscious and socially responsible. They want to know what the truth is, what their options are, and if they can use fewer inputs, they want to," Bullock said. "The benefit that I get from working with farmers is that they tell us what's important and help us relate the data to their systems — the value is in their experience and intellectual input, rather than their physical work."

Preliminary analyses of data from the study, terminated at the end of spring 1993, show hairy vetch is promising as a cover crop in southern Illinois, but not as good in central Illinois. Farmers in northern Illinois might as well "bury their money" as plant hairy vetch after soybeans, according to Bullock.

"For the central part of the state, the only way to get vetch to survive and produce is to plant it after wheat or very early soybeans," he said. "The winter is just too severe."

When hairy vetch survived the winter, the crop could be measured in inches in Fisher, compared to knee-high in Greenup and hip-high in Albion. Nitrogen from hairy vetch tended to be lowest in Fisher and highest in Albion. The crop's nitrogen supported grain sorghum but was not enough for corn.

Hairy vetch used solely for fixing nitrogen is expensive, Bullock noted. The costs for seed and for herbicides to kill the crop can offset any economic advantage from the nitrogen contribution.

But if erosion control is taken into account, hairy vetch can be a good investment, he added.

Rye lacks the nitrogen-fixing ability of hairy vetch but offers more flexibility in terms of geography, according to Bullock's data. Rye provided good cover protection through all winters of the

study. Bullock used herbicides to kill the crop before planting soybeans or corn. In keeping with the goal to reduce soil erosion, the grain crops were planted without tilling the soil first.

The rye showed allelopathy, or naturally occurring chemical protection, against some weeds and also against corn and sorghum. That, combined with the dense plant coverage, suggests certain weed populations might be reduced over time where rye is planted, he noted.

Holsapple said the study confirmed suspicions he had about the limitations of hairy vetch and rye. "We've always wondered about using vetch behind soybeans. We expected the late planting date could be a problem and found that was true.

"But beyond finding answers to our questions, it was invaluable to learn how the UI folks do research. It was interesting to walk through the study and see the different variables — not that I believe this is the only way to go, but it worked for the questions we had about cover crops. We found out some things we wanted to know, and now we can go out and tell others."

That kind of sharing of research results is "probably the best way to get the word out," Bullock said. "Cover crops are not a panacea but can be used to improve certain situations, particularly in southern Illinois where erosion is more severe and soils are not as rich. No-till into vetch and rye could be a wonderful system for keeping the soil where it belongs."

This project was funded in part by the Fertilizer Research and Education Council.

Old Rotation, New Technology

Bullock's newest on-farm research project looks at questions farmers are beginning to ask about livestock. Livestock, once common in the Midwest, might be one way to bring more diversity and options to grain farms. For instance, livestock might provide alternatives in fertility management. During problem years, livestock could eat crops unsuitable for harvest.

For this study, Bullock and Jim Kaiser, a UI associate professor emeritus of agronomy, collaborated on experimental designs that will allow the researchers to assess intensive grazing systems for cattle. Robert Hornbaker, a UI agricultural economist, will track and analyze economic consequences of the systems.

STEPHEN HUNTS

Gary Ewing (left) and his son Kerry are collaborating with UI researchers to study the effects of intensive grazing on the Dudley Smith Experimental Farm near Pana, in central Illinois.

"Does it make sense to bring cattle back on the farm in terms of economics? In terms of time management? These are the basic questions we're looking at," Bullock said. "Livestock used to be part of most farms, but never in systems of intensive grazing. This is an old rotation, with new technology."

To study how intensive grazing might fit into a normal farm operation, researchers plan to place cattle on 20 acres of 1-acre fenced plots; 50-acre plots; and 100-acre plots. The fenced plots are planted to annual alfalfa. The study also includes a perennial alfalfa pasture for livestock feed.

"Now, farmers raise corn and beans and ship them to feedlots for cattle. We want to know if we can use these newer grazing technologies to increase diversity on the farm, and if so, is it better?" said Bullock.

Kerry Ewing, a fourth-generation Pana farmer, will tend the livestock on one of the four corn and soybean farms he and his father, Gary Ewing, farm for Dudley Smith. Smith, 98, recently gave the 224-acre farm to the UI, with the stipulation that it be used for agricultural experiments.

"Dudley Smith was always looking to the future, always looking for a better way," the elder Ewing said, recalling a time when Smith planned annual farm tours from his home in North Carolina. "He had 5,000 acres in central Illinois, and he wanted his heirs to have a feel for the ground. The farmland was more important to him than the money that came from it."

Gary Ewing remembers when livestock were more common in the Midwest and has reservations about "growing livestock instead of grain."

"This farmland is so productive that not growing grain could bring a loss," he said. "But there could be some value to the land in bringing livestock back."

Kerry Ewing, who already tends to a farrowing-to-finish hog operation on another farm, has experience with cattle from earlier years.

"I like cattle," he said. "I'm as curious as anyone to see whether this intensive grazing plan will work. When we had cattle on pasture, it took three times the land they're talking about."

The Ewings are particularly curious to find out if integrating cattle into the operation might benefit the soil.

"It will be interesting to see whether resting the ground from grain production changes it — whether alfalfa helps the ground and whether there is some effect on nitrogen fertility when we go back to

corn," Kerry said. "I expect to see a lot of neighbors and farmers stopping by to look and talk about this."

Researchers also expect high interest in the project and are planning to have on-farm demonstrations and exhibits as results are available. This project is funded in part by the 1993 North Central Low Input Sustainable Agriculture Program through 1995.

Farmers Make an Impact

A third project focusing on systems of sustainable agriculture takes a personal look at three farmers and their operations. Using computer technologies, researchers will assess the environmental, economic, and social effects of management decisions these farmers make over several growing seasons.

"This study is designed to connect thinking with decision making and illustrate the impact," said Richard Warner, leader for the UI Agro-Ecology Program. "It's really a very personal focus on these farmers. It's getting into their heads and into their lives to have them reflect on what they've gone through and the impacts of what they've done."

Jack Erisman of Pana is one farmer prepared to put his farm and farming style under the microscope. Erisman farms about 1,800 acres of corn, soybeans, wheat, oats, rye, hairy vetch, hay, and buckwheat. At the "south edge of the guaranteed Corn Belt," he characterizes his soils as "good, but not as forgiving." In the 1960s, his concern for the soil prompted him to take stock and take action to improve the chemistry of the soil.

Over time, he changed the way he used agricultural chemicals and tillage. Today, he farms organically and reduces tillage operations whenever possible, bringing the chisel plow out only occasionally.

"There are always too many variables in farming to know what really makes a difference," he said. "I've done some good things and some things I thought were good at the time, but unbeknownst to me were bad. Things I thought were a great improvement because of conservation were not always so. Knowledge changes

Lessons from On-Farm Research

Environmentally Sensitive

Approximately 26 percent of the 10.5 million acres of corn grown in Illinois each year are not rotated with another crop. Nearly 90 percent of these "continous" corn acres are treated at planting with a soil insecticide. Unnecessary use of soil insecticides costs producers money and may carry an environmental price tag in the form of a potential hazard to birds and fish. Fortunately, there are alternatives to the overuse of soil insecticides. These alternatives, part of a farming approach called integrated pest management, are being studied by researchers with the University of Illinois's Office of Agricultural Entomology.

Integrated pest management (IPM) is an environmentally sensitive approach to farming that discourages the misuse and overuse of insecticides. For example, when corn is grown in the same field year after year, pests such as corn rootworm are more likely to find the field hospitable and cause major economic damage unless producers apply soil insecticide. However, when other crops such as soybeans are grown in rotation with corn, the life cycle of the corn rootworm is broken without the need for insecticide. This no-cost solution is an example of IPM in action.

Soil insecticide use peaked in the late 1970s and early 1980s. In Illinois, soil insecticide use dropped from 9 million pounds in 1978 to 3.6 million pounds in 1990. This sizable decrease translates into significant economic and environmental benefits to producers and the general public. Further reductions in soil insecticide use must come from refinements in the management of corn rootworms in continuous corn. In 1986, the UI began a series of ongoing research projects on farms in northern Illinois to identify these necessary refinements.

In 1986, UI agricultural entomologists began to look at how much economic damage was caused by rootworms in cornfields planted after soybeans. The researchers surveyed 1,100 fields in northern and central Illinois counties during July of 1986, 1987, and 1988. Survey results showed that economic rootworm injury in first-year corn occurred in only 1.7 percent of Illinois fields. Armed with this new information, Cooperative Extension Service specialists reassured growers that soil insecticides were rarely needed to prevent economic losses in corn grown after soybeans.

IPM is concerned with getting peak efficiency out of chemical management approaches. Using less insecticide more effectively reduces environmental hazards and saves the farmer production costs. In an effort to identify soil insecticide application rates that would give farmers the best return on their investment, the same team of entomologists coordinated fifty-eight on-farm research experiments in continuous-corn fields in ten northern Illinois counties during 1990 and 1991. The results indicate that farmers willing to calibrate their planters can achieve satisfactory root protection by reducing the rates of some products. Currently, many producers across the Corn Belt rely on these findings to decide how much soil insecticide to apply. A 25 percent reduction in the application rate of soil insecticides would reduce the amount of active ingredients applied in Illinois by well over 1/2 million pounds annually.

The 1990 and 1991 on-farm studies revealed that only 45 percent of the experiments had root injury at or above the economic injury level. The economic injury level is reached when the cost of injury (usually expressed as yield loss in field crops) equals the cost of control. In 1990, the majority of growers gained marginal profits with the labeled rate ($0.70/acre) and lost money by utilizing the

Approaches to Farming

lower application rate ($1.07/acre). The following year, farmers in the study lost $2.48 and $0.27 per acre by applying labeled and reduced application rates of soil insecticides, respectively. These experiments indicate that soil insecticides are used more often than necessary in northern Illinois and, in many instances, do not represent a sound investment in pest management.

As UI agricultural entomologists continue to assess the economic impacts of soil insect damage and the use of soil insecticides, they are also investigating other management strategies. Producers want more information about nonchemical management strategies for insect pests. The tolerance of modern corn hybrids to rootworm feeding and the use of parasites to control corn borers are just two of the strategies being explored. Researchers and producers will work closely together to learn whether these tactics will work on the farm. — *Michael E. Gray, associate professor, and Kevin L. Steffey, professor, Department of Agricultural Entomology*

Michael Gray (top left) and Kevin Steffey rate corn roots for rootworm injury at a recent field day. Healthy roots (bottom left) and injured roots are sometimes quite easy to distinguish.

Photos courtesy of Kevin Steffey and Mike Gray

and so farming continues to be a learning experience."

From experience, he said, he knows now that when he has to use tillage, the timing is more important than the tool. He brought the moldboard plow out of retirement in 1977 when a fall hail storm put 15 bushels per acre of corn on the ground. But a comparison of chisel-plowed fields to 270 acres he plowed with the moldboard showed little difference in volunteer corn.

He knows he can forgo pesticides without affecting yields. When he broke from organic farming to invest in cutworm control in 1983, it did not pay off, he said.

He knows he can spend less money on purchased inputs for fertility and still get as much net profit by using a variety of management strategies. For instance, problem potash levels on a piece of ground improved when he converted it to pasture for cattle.

"It's difficult to quantify everything for a site, and maybe we've been too focused on defining and managing when what we need to do is discover the natural elements of productive capacity, rather than manipulate elements of managed capacity. We may need to stand back and see what happens, and then try to understand in a holistic sense the ramifications of what we do," Erisman said.

Researchers who work with Erisman will have access to his records, including extensive soil testing records and a pest database compiled over several seasons of scouting. As important as the records, however, will be finding out why he made particular management decisions over the years.

"The scouts thought I did nothing with their information because I didn't apply treatments at the economic thresholds," he said. "But action wasn't necessary in my mind. I wanted to know what was out there and then I made the choice to take another chance — as a farmer, I can do that. The 'experts' have themselves and their integrity to protect, but I have the farm."

A concern for the farm and for the future of agriculture motivated Erisman to open his records and his mind to researchers. In particular, the trend for agri-

Studying the Whole Farm as a Sustainable System

Current research in sustainable farming systems tends to focus on agronomic and profitability issues, neglecting social and cultural factors. Scanty information is available about the social, cultural, economic, and environmental effects on farm families and rural communities of adopting more sustainable systems.

To help fill this information void, a current College of Agriculture project is uniquely designed around the collaboration of a multidisciplinary research team that includes an anthropologist, a natural-resources Extension economist, and an agronomist. By simultaneously examining the social, cultural, environmental, and production factors of a farming system, the project aims to generate the first interdisciplinary database incorporating a true whole-farm perspective.

The project pivots on data collection entailing in-depth interviews with sixty families — a set of ten Illinois farm families using sustainable farming systems was paired with a set of ten families using conventional farming systems in the three major soil zones of the state: the northern, the central, and the southern. As much as possible, the families were selected to resemble one another in ethnicity, lifecourse phase, farm size, proportion of land owned, soil productivity, and geographical conditions. By holding these factors constant, the investigation concentrates on the farming-system contrasts between the family pairs, and casts into sharp relief possible differences in cultural and social factors associated with the adoption of a sustainable rather than a conventional farming system.

Each family pair was studied during several days on their farm. The data base collected comprises three parts: the physical aspects of the farm; production practices; and the social and cultural characteristics of the farm family. Family histories, division of labor, goals, ecological beliefs, and succession plans were some of the information asked. The physical description of the farm and surrounding area, detailed production and economic information (including production costs, assets, and debts) were obtained. From these data, each farm's ecological and economic viability can be estimated. Statistical analysis will be used to indicate general physical, production, and economic factors associated with the adoption of sustainable farming and the factors associated with maintenance of conventional systems. This information, when combined with the qualitative data about families and communities and subjected to statistical analysis, will allow us to quantify the relative importance of the physical, production, and economic factors versus the social and cultural factors for each farming system. Furthermore, these data will enable us to identify whether it is the family or other properties of the farm that account for differing production and environmental outcomes.

From the data about real families, an innovative Cooperative Extension educational publication of case study materials will be developed. These materials will identify the real-life costs and benefits to families of adopting sustainable versus conventional farming methods. The case studies will provide a concrete means of helping families address the complex choices involved in adopting a farming system. *— Sonya Salamon, professor of family studies; Richard Farnsworth, associate professor of agricultural economics; and Donald G. Bullock, associate professor of crop production*

culture to be concentrated into fewer hands as technology makes larger operations possible is one reason to look at some of today's successful farms, he said. His hope is that this project will help those in agriculture develop "a sense of holism," or a recognition that farming has social, environmental, and other impacts.

"It's difficult to pinpoint a place in time and say, 'yes, we've got the best sustainable system' because farming is constantly evolving in close relation to population growth, infrastructure changes, fads, demand changes, processors, manipulation of markets, economic pressures, and such," he said.

"But do we need 10,000 acres to be competitive? Is that the kind of farming we want? We need to plan otherwise if it isn't," he said. "We need to determine what kind of system we want and what kind of system we will allow. And in this kind of system, can we survive? If so, is there a model way to do it? Is it a sustaining model for the sociopolitical, socioeconomic long term?"

Researchers will use the information they glean from Erisman and the other farmers to create computer simulation programs that illustrate impacts from farm-management decisions. These programs could be used as teaching tools by the Cooperative Extension Service and other agencies, Warner said. Warner also envisions the computer programs helping producers see how the changes they consider will affect farm economics, natural resources, and the landscape.

"In a sense, it's a vision of the future," he said. "A farmer might say, 'I want more wildlife habitat, so I'll do this to get that.' And they might get more wildlife, but they also create social, economic, soil, pest management, and a host of other changes. We want to help them see that."

The computer farming systems demonstration project is partly funded by the U.S. Department of Agriculture through the North Central Region Sustainable Agriculture Research and Education Program.

Tina M. Prow, science writer, Agricultural Experiment Station

Muddled Environmental Claims Muddy the Waters

Brenda Cude

Nobody wants to be responsible for damaging the environment for future generations. That's why many of us are eagerly looking for ways to reduce the environmental impact of our purchase, use, and disposal decisions. In fact, polls show that many consumers say they will not only buy the more environmentally responsible choice, but they will also pay more for it.

Unfortunately, acting on those good intentions is not always simple. First, it's often not clear which choice is more environmentally responsible. Is it better to buy a product in a package designed to reduce waste by 80 percent (but not recyclable) or one with more packaging but made from a material that can be recycled? The answer is usually "it depends." Will the recyclable package actually be recycled? Are there markets for the recycled materials? Will the recycled package actually be used to produce new products or packages?

Another reason some consumers find it hard to buy environmentally sound products is lack of information. In many purchase decisions, consumers can use the information on product labels and in advertising to help make decisions. That

PHOTO-COMPOSITE BY DAVID RIECKS

Ever feel bombarded by environmental claims? If so, join the crowd — consumer-science experts say that confusing language on product labels can make it difficult to be an environmentally responsible shopper.

Master Recyclers a Masterful Plan

In many states, including Illinois, the Cooperative Extension Service (CES) trains master volunteers to share their knowledge about environmental consumer decision making with the community. CES volunteers earn the title of "master" by completing an intensive training program grounded in unbiased, research-based information. Topics in an environmental consumer decision-making volunteer program include green labeling, recycling, composting, proper use and disposal of hazardous household materials, waste audits, and others. In exchange for the training, the volunteers agree to "pay back" the community by volunteering their time and new knowledge to help community groups and individuals with their waste reduction and recycling efforts.

In Illinois, the CES offices in Lake and DuPage counties developed a Master Recycler Program. Volunteers receive 40 hours of training and must pay back 60 hours of service. The training includes a tour of a landfill, hands-on decision-making activities in a supermarket, classroom lectures from a variety of speakers, and training on how to teach others. Master recyclers have worked with local businesses and schools to implement waste-reduction practices and recycling, served on county solid-waste-management committees, helped multifamily units start recycling, prepared displays for library and teaching unit staff who speak to community groups, and developed a directory of where to dispose of recyclable materials. — *Brenda Cude*

STEPHEN HUNTS

Recycling volunteers "give back" to the community in more ways than one.

help isn't always available for decisions about a product's environmental impact.

The problem hasn't been that marketers don't mention environmental claims in their labeling and advertising. They do. Environmental claims appear in most product categories; for example, in 1992, 50 percent of all paper and plastic bags and 46 percent of all laundry and cleaning products carried environmental claims.

But just what do the words and symbols that appear in labeling and advertising mean? Unfortunately, the significance of product claims is often lost in a muddle of unfamiliar or ambiguous terms.

Diving into the Murk

University of Illinois Extension staff in the area of consumer sciences have examined the environmental claims that marketers make and consumers' perception of them. The Extension staff collected data from over one thousand consumers in 1991. The project began in response to a call from the Federal Trade Commission and the Environmental Protection Agency for data on consumer perceptions of environmental claims such as *biodegradable*, *compostable*, and *recyclable*. Both agencies were considering issuing regulations and had scheduled public hearings. To provide the testimony in time for the hearings, the UI research team gathered the data in less than a month, then analyzed the results and wrote testimony that was presented to both agencies.

The survey results showed that consumers have a fairly good understanding of the terms *recycled* and *recyclable*. Most consumers knew that both terms have something to do with recycling. However, few could write a complete definition of a recycled product or package as one that is made partially or entirely from materials that have been reprocessed. While some consumers correctly defined a product or package labeled *recyclable* as one that could be collected and processed to make a new product or package, 33 percent incorrectly thought that it meant the package could be sterilized and reused. Less than 25 percent of consumers defined *post-consumer waste* as collected after consumer use, and fewer than one-third knew that *pre-consumer waste* is collected from manufacturers and distributors.

In general, consumers had little or no knowledge of the meaning of many of the other terms in the survey, including *degradable*, *biodegradable*, and *no CFCs*. Consumers were also unclear about the meanings of *safe for the environment* and *environmentally friendly*.

In July 1992, the Federal Trade Commission (FTC) issued guidelines for marketers to follow in making environmental claims. These guidelines do not have the force and effect of a law, but they are still expected to make a difference in environmental claims.

The guidelines set out general principles and also give specific instructions for making claims for products and packages that are degradable; compostable; recyclable; contain recycled content; are reduced in weight, volume, or toxicity; refillable; or ozone-safe. Marketers who follow the guidelines will steer away from claims that overstate environmental benefits such as claiming degradability for a trash bag intended for a landfill where degradation is unlikely. Marketers will also avoid brand names like "Eco-Safe" or

claims of environmentally "friendly" or "safe" that misrepresent the product or package by claiming it offers a general environmental benefit.

According to the guidelines, degradable claims should be substantiated by scientific evidence that the material will completely break down and return to nature. Claims about compostability should be qualified if the material cannot be safely composted at home or if municipal composting is not available. Recyclable claims should include a qualification about limited recycling collection sites; the FTC recommends that labels advise consumers to investigate whether recycling facilities are available locally or that labels state the percent of communities where that material is recycled. Recycled content claims that follow the guidelines must state the percent of recycled content if it is not 100 percent.

Since the fall of 1992, a research team composed of scientists from the UI, the University of Utah, and Oregon State University have collected data every six months on the environmental claims appearing on selected product labels in supermarkets in five states. The team's goal is to document changes in environmental claims between 1992 and 1995, the first three years of the guidelines. The FTC chose this time period for reevaluating the guidelines.

After the first year, the research team learned that there was little general change in the number of claims manufacturers make. In most product categories, the number of claims remained the same or dropped; the number of claims made for laundry detergents, liquid dish soaps, and tampons increased. In some product categories (plastic trash bags, tampons, bathroom tissue), a few brands made claims to position themselves as "the" environmental alternative, and most of the other brands in that category made few, if any, claims. For other products (breakfast cereals, soft drinks in plastic), there was amazing consistency across the various brands in their environmental claims. For example, the majority of major, brand-name breakfast cereals now carry the recycled symbol and the statement "carton made from 90 percent recycled paperboard; minimum 35 percent post-consumer content." The claim almost always appears on the top flap of the box.

There are indications that marketers are shifting to become more consistent with at least some of the guidelines. Post-consumer recycled content claims are on the rise in many product categories. Recyclability claims are common and usually qualified, especially for plastic. Degradability claims are rare, and when they do appear they are carefully qualified.

These changes are encouraging, but there are others that may result in greater consumer confusion. The research team has noticed a proliferation of symbols. Each of the trade groups (plastic, steel, glass, soft-drink bottles) has adopted its own "corporate logo" related to recycling. Even the recycled and recyclable symbols are presented in as many as eight different ways across the product groups the team is investigating. The numerous symbols potentially create a level of confusion that will paralyze consumers. In any case, it may be some time before the muddy waters of environmental marketing claims clear.

Brenda Cude, associate professor of family economics, School of Human Resources and Family Studies

What's in a Name?

Do you know the definitions of the following?

- Degradable
- Photodegradable
- Biodegradable
- Landfill safe
- Environmentally friendly
- Environmentally safe
- Recyclable
- Recycled
- Post-consumer waste
- Pre-consumer waste
- No CFCs
- Ozone friendly

Here's what they mean:

Degradable/photodegradable/biodegradable. Degrade means to decompose. A photodegradable material requires sunlight to break apart. Bacteria actually cause the decomposition of biodegradable materials, but air and water also must be present.

Landfill safe/environmentally friendly/environmentally safe. These broad terms could mean anything. Regulators generally agree that broad terms should be discouraged.

Recyclable. Recyclable can be defined in many different ways. It could mean that the technology exists to recycle a material. It could mean that there are ongoing collection programs for recycling a material and a market for the recycled material. Recyclable on a grocery store shelf could mean that there is a recycling program for that material in the community where the store is located.

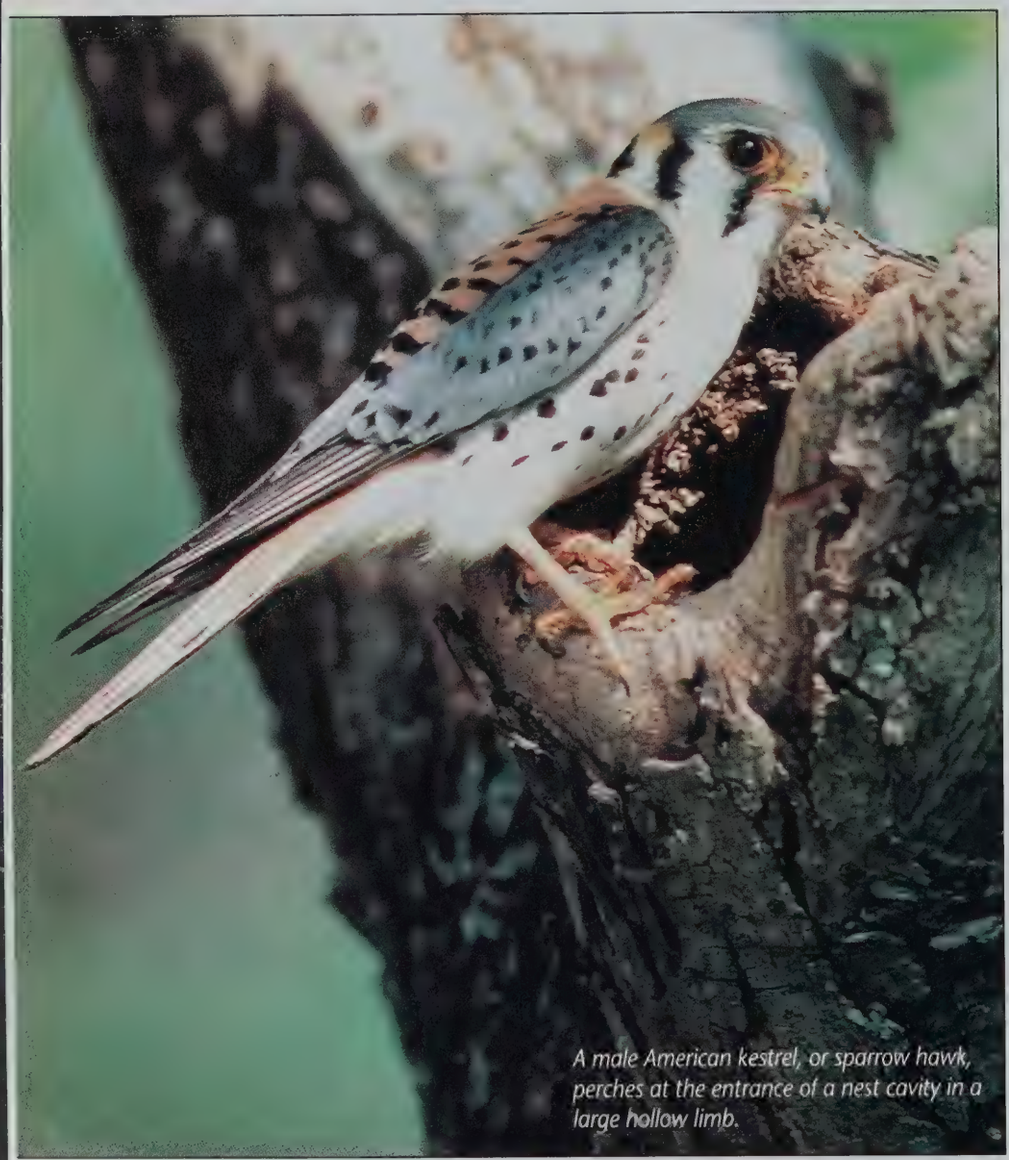
Recycled/post-consumer waste/pre-consumer waste. Recycled material may be collected from consumer recycling programs (post-consumer waste) or may be recovered waste from the manufacturing or distribution process (pre-consumer waste).

No CFCs/ozone friendly. Chlorofluorocarbons (CFCs) have been banned from aerosols for more than ten years. They are used primarily now as refrigerants and in air conditioners. However, aerosols may be labeled "ozone friendly" because they don't contain CFCs yet still be harmful to the environment if they contain other propellants that are damaging to the ozone layer. — *Brenda Cude*

Sparrow Hawks, Spiderwort, and Environmental Consciousness: A Modern-Day Parable

Robert J. Reber

A computer systems analyst commutes daily along a stretch of rural interstate. The experience is numbing. All days run together. Whether the numbness is caused by the steady stream of traffic or diesel exhaust fumes, or both, is debatable. But by chance, this late spring morning is different. The monotony is broken by a splash of deep blue that catches his eye. At the edge of a poorly drained area, where an abandoned railroad right-of-way intersects the interstate, a colorful plant is blooming. He asks himself, what was that?



A male American kestrel, or sparrow hawk, perches at the entrance of a nest cavity in a large hollow limb.

TODD FINK

His interest is heightened as he observes the area the next day and spies a peculiar, rather small hawk-like bird hovering just yards above a grassy area. He wishes he could study the bird, but 68 miles per hour affords only a fleeting glance. His level of ornithological awareness includes only pigeons, starlings, sparrows, and Canada geese.

That his sum total interaction with the rest of the natural world has been reduced to stolen glances off the interstate while traveling at 100 feet per second is a tragedy. But where there is interaction, there is hope.

An almost innate curiosity triggered by these encounters begins to nag at him. Saturday morning he decides to do something about it. Armed with his binoculars and a pair of *Peterson Field Guides* borrowed from a friend, he drives down the country road that crosses the railroad right-of-way about a half a mile from the interstate. He parks the car and begins hiking. A whole new world opens up before him. Next Saturday morning finds him there again. His weekend jaunts along the abandoned right-of-way become addictive. Each Saturday brings discovery. He is learning.

He learns that the blue-flowered spiderwort is a native plant of the original prairie. As the growing season progresses, he discovers other relics of prairies past — butterfly weed, compass plant, prairie dock, big bluestem, cordgrass, and many more. And he discovers that the sparrow

ROBERT J. REER

The blooms of spiderwort vary in color from a medium blue to an intense bluish purple.

hawk is no mere bird. In fact, it is not a hawk at all, but is the smallest of our native falcons. Its true name is the American kestrel. It is very adaptable. This incredibly designed predator is the Stealth fighter of the meadow vole's world. And yet in season, it can live almost exclusively by hunting and feeding on a lowly insect — the grasshopper.

Our computer systems analyst is embarking on a pilgrimage, final destination unknown. He is beginning to gain insight into something far larger than himself or even the rest of humanity. Environmental consciousness has been aroused. He has taken the first steps down a path that too many have abandoned. How deeply he will explore his relationship with the rest of nature is unknown. How far he will have to travel down the path until he reaches a level of environmental consciousness that begins to satisfy is also problematic. Each person's pilgrimage is unique, like their thumbprint. But like all human thumbprints, there are commonalities.

As we and our pilgrim travel down this path, we are faced with basic questions and concepts. How do I fit into the whole of nature? How am I connected to it? How inclusive is my community and what are my responsibilities to its members? Why is nature so beautiful? How should I respond to its beauty? Like nature, these questions are interconnected and interrelated. Though we have come to expect instant answers while traveling at 100 feet per second, answers aren't easy. We can spend a lifetime searching.

People and Nature

Who am I? Where did I come from? These are the most fundamental of all human questions. How do I fit with the rest of nature? is a related question of this same magnitude. That humans are part of, rather than apart from, nature is accepted as a given by many who have traveled the environmental consciousness path. However, interpretations vary. To some, humans are a part of nature only in some vague, abstract, figurative sense, and their interpretation stops there.

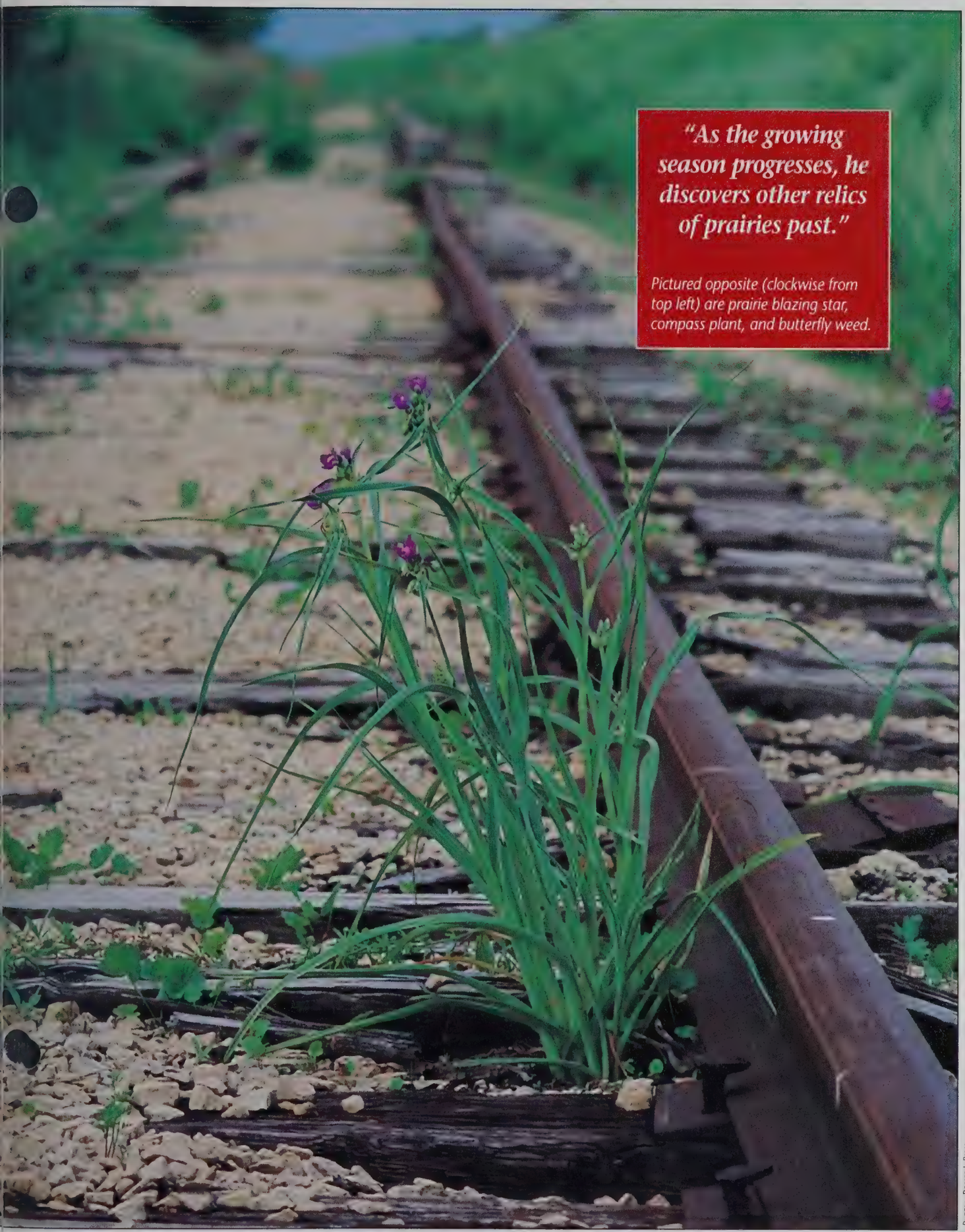
Others add a very personal interpretation. To them, we are figuratively and literally a part of nature. This more literal interpretation helps us to come to grips with the cycle of life and death and our own mortality. Our physical bodies have only a transient lease on life-giving atoms that are on an endless odyssey. Someday the iron in our bodies may be needed to build blood for a red fox, or a sparrow hawk, to give them life. Nature is literally "bone of our bones and flesh of our flesh."

Nature's Connectedness

The question of the connectedness of nature is central. And it is one that our pilgrim and we must contemplate. Some connections, and the cause and effect relationships they explain, are obvious. Our lives are firmly rooted to soil. To envision soil erosion and other forms of land despoilment leading to human starvation doesn't require much stretch of the imagination. The sequence of events that result in hunger and starvation can be easily described and explained. Despite the simplicity of these connections, past civilizations have wasted soil, destroyed lives, and have fallen in the process.

Over seven thousand years ago, Mesopotamia gave birth to civilization and agriculture as we know them. Mesopotamia was the location of the Fertile Crescent, and according to Bible scholars, the Garden of Eden. In an attempt to increase production, Babylonian king Nebuchadnezzar constructed an elaborate system of irrigation canals. But the water that brought increased affluence also brought ruin. The irrigation water carried salt. This salt, along with the salt already present in the soil, accumulated at the surface and destroyed productivity.

We are now repeating history. Irrigation has produced the same results in the Central Valley of California. The only



"As the growing season progresses, he discovers other relics of prairies past."

Pictured opposite (clockwise from top left) are prairie blazing star, compass plant, and butterfly weed.

PHOTO BY ROBERT J. REBER

Wapiti (a subspecies of elk) crossing the grasslands of Illinois was once a common sight.

thing we seem to learn from history is that we fail to learn from it. In part, this lack of learning is due to lack of memory for historical precedent. But also, pervasive human arrogance that places our status far above the rest of creation limits our receptivity to learn from the past.

As we look further into nature's connectedness, we find other linkages that are sometimes difficult to see. We become overwhelmed by complexity. There are cycles within cycles. It is beyond our comprehension. At some point we may conclude that "everything is connected to everything else" and that "we can never do just one thing." Every action seems to have unexpected and unintended results.

Out of Native American mythology has risen the belief that "picking a wildflower touches a star." Early in our journey as we stumble over the more obvious connections like so many railroad ties on the abandoned line, we may value this belief only as a beautiful, figurative abstraction. Further down the right-of-way and our own personal right-of-passage, as we become awed by nature's connectedness, we may be inspired to consider the literal possibilities.

Community of Nature

For many, the concept of community is formed in our immediate family. Our community may then be enlarged to include our extended family, friends and neighbors, and so forth. Within our own species it may be expanded to include the entire global village.

But what about the rest of nature? If our community includes other species, which ones and why? Are only those capable of consciousness thought eligible for membership? Mammals such as chimpanzees and dolphins, who have a high brain weight to body weight ratio, have been shown to initiate tool use and/or develop sophisticated levels of communication. Should we use intelligence as one criterion for community membership?

We could consider all species possessing a central nervous system, or we could go further and include plants as part of our community. Some feel that community limits can be extended beyond living organisms to include the very rocks, the air, and the water. This holistic enlargement to include everything in one's own community corresponds to naturalist Aldo Leopold's concept of the "Land Community." His community included the soil, air, water, and all biologic species. To him it represented a unified whole, inextricably linked together by both cooperative and competitive relationships. He stated simply, "The land is one organism."

This all-inclusive view of community is reflected in the Gaia Hypothesis proposed by British scientist James Lovelock. Lovelock concluded that the entire Earth acts as one giant, living organism with checks, balances, and feedback systems that allow self-regulation. This concept of the Earth as a unified whole that functions as a living organism supports our current move toward systems-based research and management strategies.

Why is it pertinent to consider the limits of our community? Leopold believed that in order for a person to extend ethical consideration to another entity, that entity first had to be accepted into one's own community. If true, this has serious implications for us as we search for a more durable scale of values and a rationale for an environmental ethic. What makes up our community is pivotal.

Nature's Beauty

As our pilgrim sees butterfly weed in bloom for the first time, he is struck by the fire-orange glow. He thinks to himself — how beautiful! The literal, physical beauty of nature is where most of us start. And even though beauty is in the eyes of the beholder, there are species and objects in nature that are almost universally accepted as beautiful. Most are captured by the azure blue of spiderwort or the sun's rays playing off the blue and russet of a hovering sparrow hawk.

However, as our environmental consciousness grows, we realize that nature's beauty is more than skin deep. We begin to refine our aesthetic perception. As our appreciation and understanding deepens, the very patterns and processes of nature become beautiful. To our pilgrim, spiderwort becomes more than a prairie plant that once a season makes the commute more bearable.

Spiderwort has witnessed the geologic and biologic patterns and processes that gave genesis to prairie. Spiderwort felt the searing heat of prairie fires. Some were set by lightning strikes. Others were kindled by Native Americans. This plant heard the hooves and heartbeats of bison and wapiti as they grazed and moved on, like vessels across an open prairie sea. And locked within spiderwort is a genetic memory of how it responded to these patterns and processes. The sum total of spiderwort's natural history was a seasonal mosaic beyond comprehension.

At some point, our pilgrim declares that the natural history of spiderwort is beautiful. Its natural history contains a refined aesthetic that passes all understanding.

The literal and figurative beauty of nature is of critical importance because it can spark within us a love for nature that some have called "biophilia." Eminent Harvard biologist E.O. Wilson defines biophilia as the "urge to affiliate with other forms of life." Biophilia is defined more broadly as "the passionate love of life and all that is alive," by Erich Fromm, noted German-born psychoanalyst. By either definition, it could be argued that biophilia is the most common unifying principle that fosters a growing environmental consciousness. And it could be further argued that biophilia is the strongest force to motivate our species to serve as humble stewards of the Land Community.

In the article "Love It or Lose It: The Coming Biophilia Revolution," which appeared in a recent issue of *Orion* magazine, David Orr suggests that a whole continuum of possible orientations toward nature exists. At one end of the spectrum, he places biophilia — at the other, biophobia. He defines biophobia as an "aversion to nature...a culturally acquired urge to affiliate with technology, human artifacts, and solely with human interests regarding the natural world." In this context, we would expect environmental consciousness to develop hand in hand with a progression of shifts to the biophilic end of the spectrum.

Orr draws on familiar words from Deuteronomy to make a point:

I have set before you life and death, blessing and cursing: therefore choose life, that both thou and thy seed may live.

— Deuteronomy 30:19

These eloquent words are filled with many meanings, interpretations, and applications. When we contemplate this passage, we could ask the question that E.O. Wilson poses: "Is it possible that humanity will love life enough to save it?" Loving life enough to choose life, in all its forms, is sound strategy. The instruct of the writer of Deuteronomy is clear. The choice is ours.

Robert J. Reber, associate professor of nutrition and a managing editor of The Illinois Steward *magazine*

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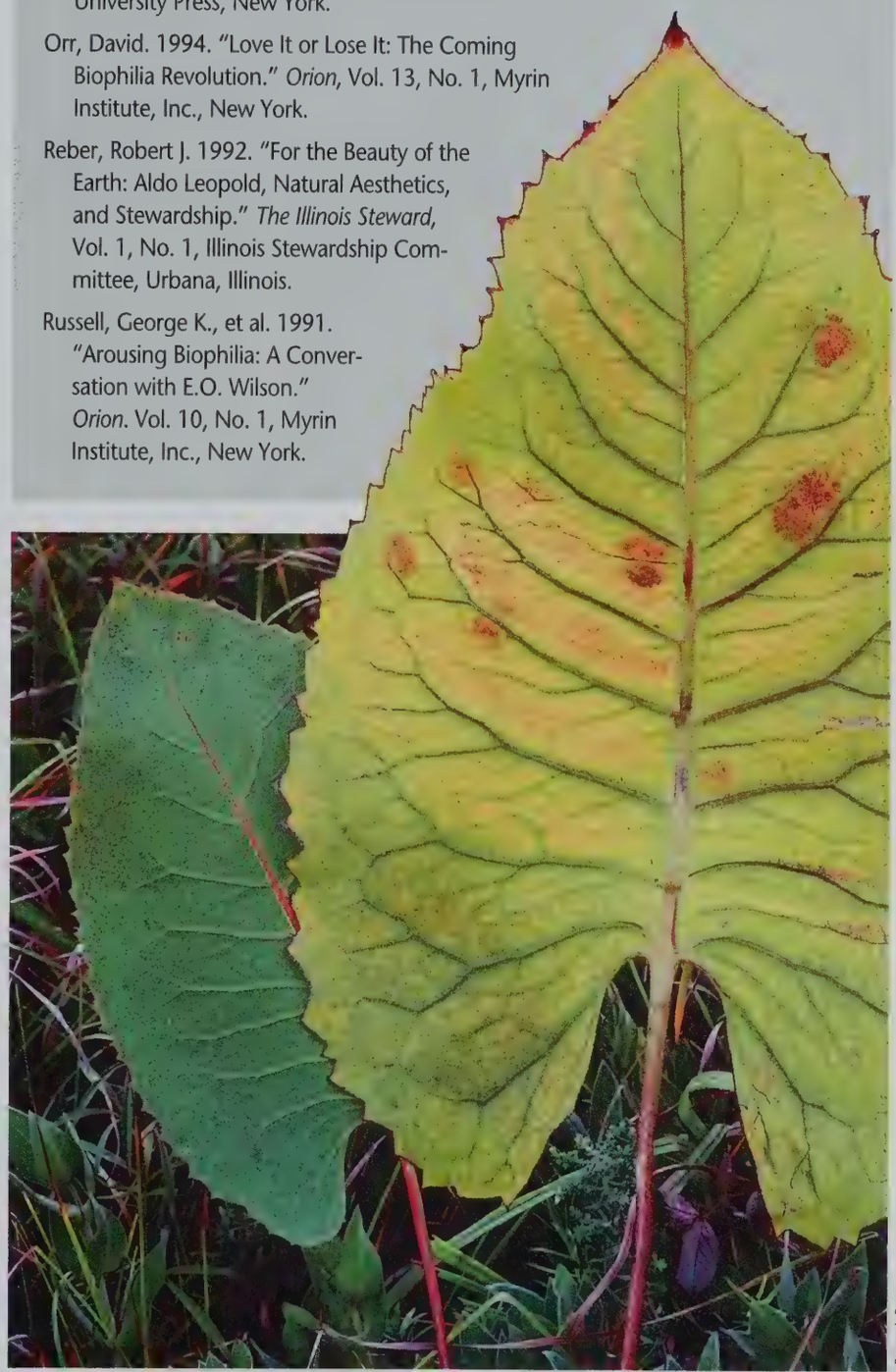

ROBERT J. REBER

The vein pattern in a prairie dock leaf symbolizes the connectedness of nature.

Station Profile

Deborah Cavanaugh-Grant


David Riecks

Having a vocation so closely tied to her avocation makes Deborah Cavanaugh-Grant "one of the lucky ones." Working closely with UI Agricultural Experiment Station staff, she directs the Illinois Sustainable Agriculture Network.

"Everything I'm personally interested in ties in somehow to my job," she says.

Cavanaugh-Grant raises goats and tends laying chickens on a hobby farm near Greenview, Illinois. She also grows hay and raspberries and is working to get organic certification for the crops. Keenly interested in agriculture and the environment, she has leadership roles with the Illinois Organic Crop Improvement Association, Menard County Soil and Water Conservation District, and Illinois Soil and Water Conservation Society.

Cavanaugh-Grant's position with the Illinois Sustainable Agriculture Network (ISAN) evolved from her interest in farmers and farm stewardship. In the 1980s, she was working with the Department of Energy and Natural Resources (ENR) when sustainable agriculture and on-farm research became important issues to many Illinois farmers. Her farm ties and education — undergraduate degrees in agronomy, horticulture, and education, and a graduate degree in environmental studies — made her a natural choice for ENR's sustainable agriculture program.

When the University of Illinois got a two-year U.S. Department of Agriculture grant to develop the network, with the Illinois Stewardship Alliance acting as contractor, Cavanaugh-Grant saw an opportunity to work more closely with people interested in sustainable systems of agriculture. She joined the new network to help what are now eleven diverse, autonomous participant groups (whose common link is an interest in sustainable systems) work more effectively together. Some of these groups include grassroots farmer organizations, the UI, state agencies, and nonprofit groups. When the grant ran out in 1993, Cavanaugh-Grant's ability to bridge the differences among the network participants proved effective enough to gain additional financial support from the Illinois Agricultural Experiment Station and Cooperative Extension Service.

As the only sustainable agriculture network to bring such diverse groups under a single umbrella, the ISAN is unique in this country. Cavanaugh-Grant characterizes her role as "getting consensus from the many diverse groups and individuals in order to carry out the will of the collective." That process entails many phone calls from her home office on the farm and many hours of travel to meet with participants in the network. Since joining ISAN, her calendar has carried dates for a number of farm tours and workshops, two statewide conferences, and a series of regional meetings.

Last year, she helped the ISAN write a grant for a two-day retreat organized to examine the structure of the network, improve communications, and define goals and objectives. Later, she brought representatives of every group together to develop a network-sponsored conference on soil management.

"People are key to this effort," she says. "We've got to continue to find ways to work together." — *Tina M. Prow, science writer, Agricultural Experiment Station*

News of the ISAN is published in the Illinois Sustainable Agriculture Society's quarterly newspaper, the ISAS News. To subscribe, call (217)476-3332. For more information about the network, call (217)968-5512.

In Progress

Magazine Offers Insights into Land Stewardship

Everyone would agree that fostering stewardship of our natural resources is a good idea. That is the purpose of *The Illinois Steward* magazine.

Published quarterly by the Illinois Forest Stewardship Advisory Committee in cooperation with the UI Department of Forestry, *The Illinois Steward* accomplishes its purpose by provoking thought on stewardship issues and by providing practical information to help property owners and users reach personal stewardship goals.

Past issues of the magazine have explored the pros and cons of the state's booming deer population; how and when to enlist consulting foresters; threatened or endangered Illinois flora and fauna; preserving the state's prehistory; wetland restoration; the past and present state of the Shawnee National Forest; developing a butterfly garden; feeding wild birds; and conservation tillage.

The Illinois Steward is published in a vibrant four-color format, with striking photos illustrating the text. A one-year subscription is $10. To subscribe, please call Donna Prahl, circulation manager, at (217)333-2770.

New UI Publications Explore Bottled Water, Community Water

Whether your drinking water comes bottled or through the tap, the Illinois Cooperative Extension Service provides answers about water quality through two new publications in its Land & Water series — *Bottled Water* and *Community Water*.

Bottled Water helps consumers determine whether they get any benefit in return for the added expense of bottled water. This 12-page publication also describes the major differences between bottled and tap water, and it explains how to distinguish among the various types of bottled water.

Community Water, a 16-page publication, outlines how local communities can protect their groundwater supplies through setback zones, surveys, needs assessments, regulations, and monitoring.

One free copy of any of the nineteen Land & Water publications is available by writing to: Land & Water Publications, 69-IR Mumford Hall, 1301 W. Gregory Dr., Urbana, IL 61801. Additional copies are available for $1 each. You may also be able to obtain copies at your local Extension office. For a catalog of all CES publications, write to the above address or call (217)333-2007.

Composting Project Helps Manage Waste

Illinois citizens produce an estimated 1.1 million tons of food waste material per year. Nearly 10 percent of landfills are made up of food waste.

To help Illinoisans effectively manage their food waste, the UI Department of Horticulture has joined the Illinois Department of Energy and Natural Resources to create a food-waste composting project. The composting project consists of alternating layers of food waste with landscape waste with the expectation of the landscape waste absorbing moisture and odor and discouraging animals.

"Our project takes food and recycles it into compost. This compost can be used to grow more food crops," says Project Director David Williams of the UI Horticulture Department.

Williams' department is responsible for the day-to-day operation and maintenance of the compost site, experimental design, and sample testing of raw and finished compost. The Illinois Environmental Protection Agency will use data from the project to help create standards for individuals interested in starting community compost projects.

Other organizations participating in the project are the Community Recycling Center of Champaign, the U.S. Army Construction Engineering Research Laboratory in Champaign, the UI Institute of Environmental Studies, and Organic Recycling, Inc., of Joliet. — *Sandra Casserly, communications specialist, Office of Agricultural Communications and Education*

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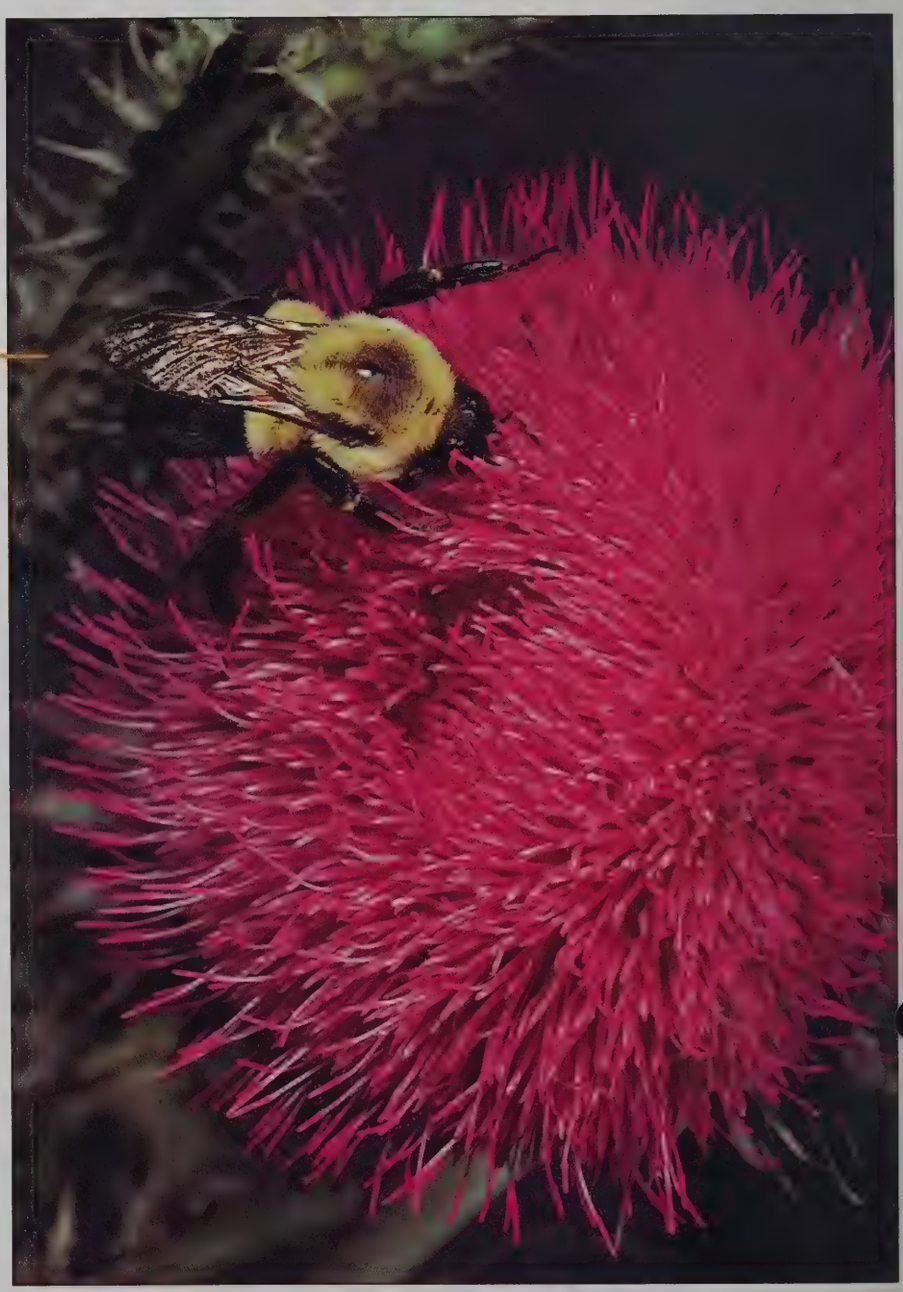


MICHAEL JEFFORDS

In the next issue:

Awesome Insects

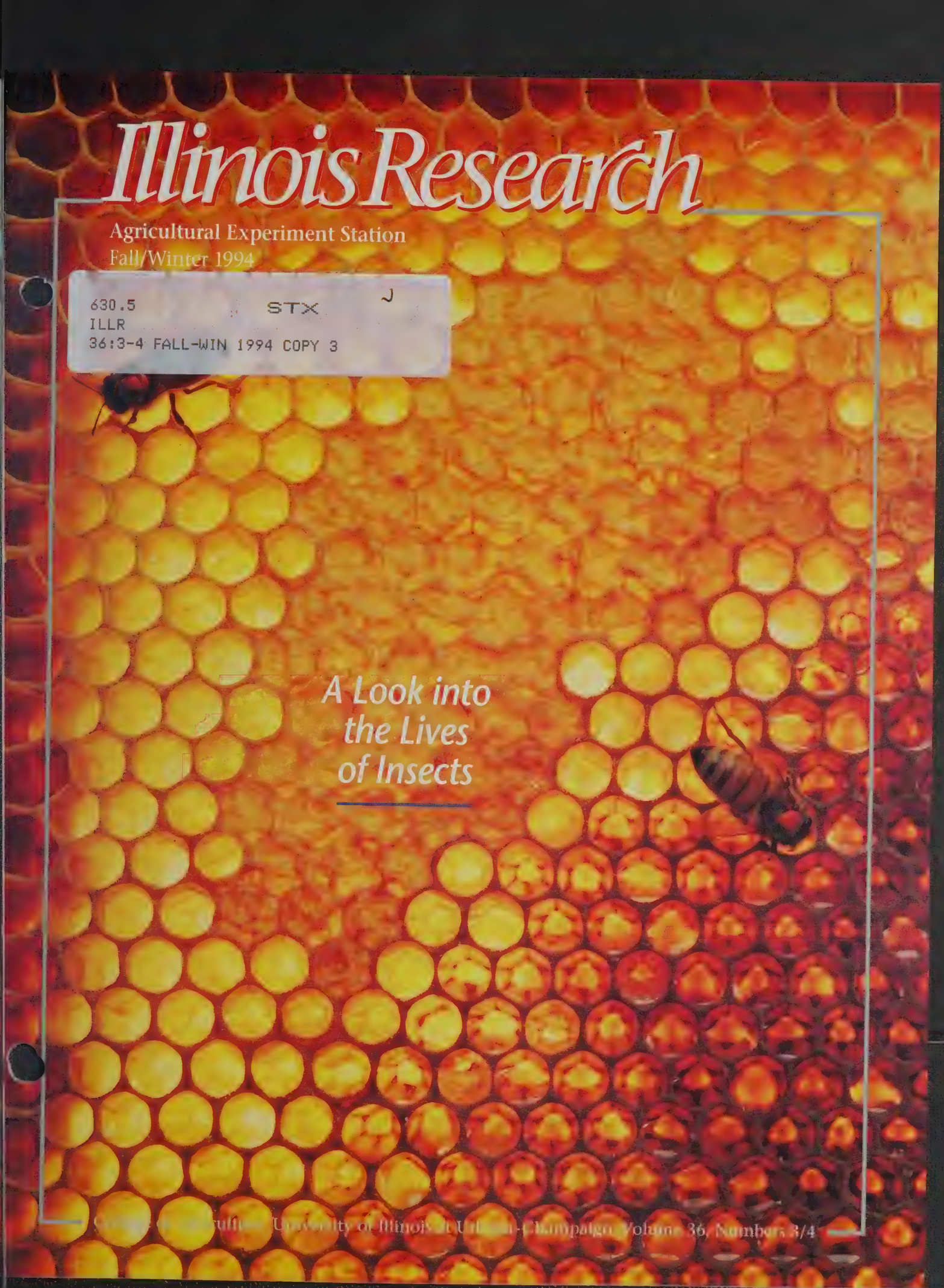
Almost everyone would agree that humans enjoy a love-hate relationship with the world's 4.5 million species of insects. We hear about harmful insects but don't know much about the beneficial ones. Take a closer look at Illinois' most notable insects, including stories about

- Integrated pest management in field crops
- Insects' direct effect on humans — mosquitoes, deer ticks, Lyme disease, gypsy moth, and more
- European honeybees
- Fear and loathing at the annual Insect Fear Film Festival
- Beautiful, unusual, and rare insects

Pictured is a bumblebee on musk thistle.

Illinois Research

Agricultural Experiment Station
Fall/Winter 1994



A Look into the Lives of Insects

College of Agriculture, University of Illinois at Urbana-Champaign, Volume 36, Numbers 3/4

The Cover

Two age-marked honey bees from the UI Bee Research Facility inspect the contents of the honeycomb. The red spots on their backs tell researchers their age. They were marked upon emergence as adults so that their age-related changes in behavior could be monitored. Photo by David Riecks.

Illinois Research

Fall/Winter 1994
Volume 36, Numbers 3/4

Published quarterly by the University of Illinois Agricultural Experiment Station

To receive a free subscription to *Illinois Research*, Illinois residents may write to the Editor, *Illinois Research*, Information Services, OACE, 47 Mumford Hall, 1301 West Gregory Drive, Urbana, IL 61801; email: n-nichols@uiuc.edu. Telephone: (217)333-4780. For bulk orders, write to the above address or call (217)333-2007. Material may be reprinted, provided no commercial endorsement is implied and credit is given to the author, the University of Illinois, and *Illinois Research*.

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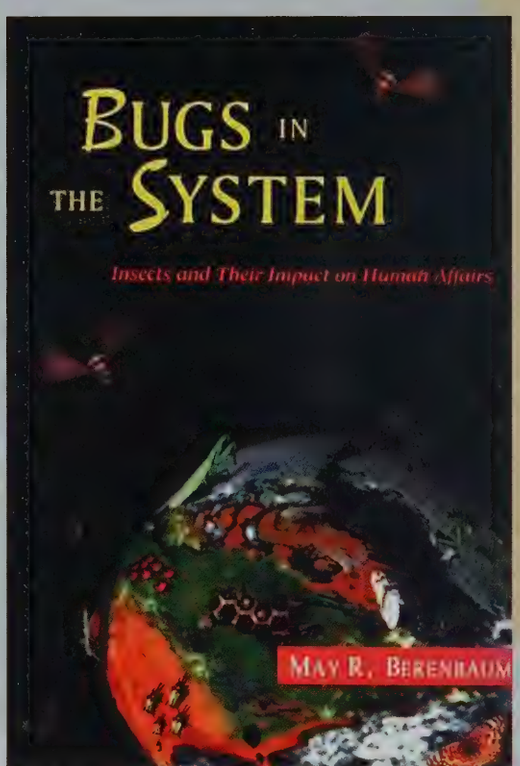


Did You Know...?

The insect facts found throughout this issue are based on information from the new book Bugs in the System: Insects and Their Impact on Human Affairs, *written by Professor May Berenbaum and published by Addison-Wesley. This entertaining book, packed with interesting facts and illustrations, is available at your local bookstore. The cartoons in this issue that accompany the insect facts were drawn by Jerry Barrett.*

A Look into the Lives of Insects

Contents

Directions

Entomology at the University of Illinois

DAVID RIECKS

This issue of *Illinois Research* records many of the successes that the great institutions and scientists in this state have registered in the field of entomology, then goes on to discuss current endeavors and future needs.

Every citizen of Illinois benefits from our work with insects. Yet through the decades the support and recognition given to entomology in this state have ebbed and flowed. For this reason, two underlying messages in this issue are particularly significant: (1) the entomological work that was initiated with commitment and foresight well over a century ago is yielding great dividends because of the continuity of these efforts over time, and (2) the need for such work has never been greater!

By the time the University of Illinois was founded in 1867, Illinois already had a state entomologist, a testimony to the well-recognized importance of entomology dating back to settlement agriculture. The UI offered its first entomology course in 1869, emphasizing "classification of insects, habits of insects injurious to the region with means of checking their ravages, and habits of beneficial insects." By 1875 the UI harbored one of the largest insect collections in the "West," setting the stage for world-renowned contributions in collections and systematics that continue today.

During the late 1800s entomology was institutionalized in a unique fashion on the UI campus with the formation of the Illinois Natural History Survey and UI Department of Entomology. Entomological research, teaching, and outreach had become part and parcel of the land-grant mission on this campus by the early 1900s, contributing substantially to the rapidly growing agricultural economy.

The fact is, the early investment by the Illinois legislature, coupled with the scientific acumen and foresight of the first entomologists, institutionalized entomology in the state and profoundly benefited Illinoisans in short order while also bearing a strong influence on the emerging fields of natural history and ecology. For example, Steven A. Forbes, state entomologist, first chief of the Natural History Survey, and first head of the Department of Entomology, is considered to be the father of ecology.

The leadership trend continues.

During the past century, numerous faculty and alumni from this campus have assumed strategic roles in entomology and ecology at state, national, and international levels. Currently entomology on this campus is supported primarily by the Natural History Survey, the Department of Entomology in the School of Life Sciences, and the Office of Agricultural Entomology in the College of Agriculture. These units work closely together, addressing unique objectives while also having recognized areas of overlap. Most entomology scientists on campus accomplish various teaching, research, and extension responsibilities with appointments in more than one unit.

As you read this issue of *Illinois Research*, you may wish to contemplate how entomology at UI has contributed to:

- Our understanding of the interrelatedness of living and nonliving things
- The need for exploiting the wealth of information contained in our large entomological research databases
- The importance of insects as carriers of disease
- The vast array of beneficial insects, the real possibility of finding new life forms (even in Illinois), and the significance of insects to biodiversity on our planet
- How teaching, research, and extension should reflect our changing technology and knowledge base
- How nonnative insects established in Illinois portray both the good and bad consequences of exotic species
- How teaching about insects has become extraordinarily creative
- How team and systems approaches are required to address the emerging complex questions in entomology.

— Richard E. Warner, interim assistant director for natural resources, Agricultural Experiment Station

Experience a World That Until Now You've Only Stepped On

Doug Peterson

"Fish gotta swim and birds gotta fly; insects, it seems, gotta do one horrible thing after another," writes Annie Dillard in her Pulitzer Prize–winning book *Pilgrim at Tinker Creek*.

Insects are neither man's nor woman's best friend.

"Most of our encounters with insects are unwelcome and unpleasant," says May Berenbaum, head of the University of Illinois Department of Entomology. "People tend to run across them in their cereal and in their closets. And when your child comes home with head lice, it does not endear him to his classmates."

Because of the often adversarial relations between insects and humans, it's easy to overlook the contributions of these crawling, flying life-forms. But according to Berenbaum, one-third of our diet is due to the pollination services of insects. As she puts it, "Our meals would be pallid without insect-pollinated plants."

If not for insects, the germ theory of disease would have had to wait a while longer to be discovered. Louis Pasteur discovered the link between germs and disease when the silk industry in France hired him to study why silkworms were dying.

"Most people are completely unaware of the extent to which life and culture are shaped by insects," Berenbaum continues. "Insects have been present on every battlefield of every war and have determined the outcome of those battles more often than have bullets or bombs."

Case in point: When Napoleon's army marched on Moscow, his freezing troops pilfered the clothes from dead bodies. As a result, they were infected by typhus, a louse-borne disease that devastated the troops. Napoleon's army dwindled from 500,000 to 5,000 in a matter of months.

"Like it or not," Berenbaum says, "insects are part of where we have come from, what we are now, and what we will be. It seems to me that's a pretty good reason for getting better acquainted with them."

The University of Illinois has been doing just that — helping people become better acquainted with insects. A variety of UI programs teach young and old how to appreciate insects and how to manage their populations to produce healthy crops. The following are just a few examples.

Insect Theater

Broadway has its *Cats*, and the Illinois Natural History Survey has its Bugs.

Aimed at grades K–6, this joint effort between UI and the Survey combines puppets, people, music, and slides to teach basic biological concepts. The Theater's theme: Experience a World That Until Now You've Only Just Stepped On.

"Insects are very charismatic; you either love them or you hate them," says Mike Jeffords, public relations and education liaison for the Natural History Survey. "They are also so diverse that you can teach just about any biological concept using insects as models."

In addition to hand puppets, Jeffords makes use of colorful, human-sized costumes, which include a tiger swallowtail butterfly, lady beetle, garden spider, praying mantis, tiger mosquito, green stinkbug, and yellowjacket.

The Insect Theater debuted at the College of Agriculture's annual Open House in March, an event that drew more than twenty-one thousand visitors. Jeffords says they now hope to take the show on the road to schools.

"We want to show children that science can also include theater, art, and literature," he says. "We want to show that science has no hard borders."

Illinois Agricultural Pesticides Conference

Between 1978 and 1990, the percentage of Illinois corn acres treated with soil insecticides dropped from 65 percent to 33 percent. UI educators are partly responsible for this dramatic cutback, for they have been bringing home a basic message since the 1970s: Most corn following soybeans does not need a soil insecticide treatment.

One way that UI entomologists deliver such insect-control recommendations is through the Illinois Agricultural Pesticides Conference, conducted during the first week of January every year. The conference is one of the oldest of its kind in the nation, dating back to the 1940s, when

pesticides were just beginning to make an impact on agriculture.

"At that time, pesticides were new and nobody knew how to deal with them," says Kevin Steffey, a UI Extension entomologist and chair of the committee that pulls together the conference.

According to Steffey, the conference was originally aimed at companies that sold and applied agricultural pesticides. But today it attracts anyone who does consulting work with farmers.

As more attention has come to bear on pesticides and the environment, the conference has adapted by putting greater emphasis on environmental issues, Steffey points out. It deals with groundwater contamination, pesticide drift, pesticide container recycling, environmental regulations, and ways to reduce chemical use.

In 1995, for instance, the conference featured new UI research on crops that have been genetically engineered to produce *Bt* — a microbial insecticide that can kill insect pests without posing a risk to humans. Organic gardeners often use *Bt* to control insects.

The key is helping farmers discover techniques that can reduce both costs and environmental damage, Steffey says. As he points out, "Education combined with economics is a powerful tool."

Insects known as ocean skaters form large floating aggregations, or "flotillas," on the surface of the ocean. They signal the approach of an enemy by wildly scattering across the water surface. The waves generated by this movement can be detected by distant ocean skaters, who immediately display the same escape behavior without ever seeing the predator themselves.

Bugs BIGGER than Life

For readers connected to the Internet, here's a brand-new information resource. The UI Department of Entomology has a new "home page" on the World Wide Web. This fount of information includes not only details about the Department's academic program (including short biographies of faculty members, course offerings, and even an application for admission) but also a database of insect images and descriptive information.

The address for the home page is "http://www.life.uiuc.edu/Entomology/home.html". You need a World Wide Web browser and a link to the Internet to access it. Questions? Call Dave Lampe, Entomology Department, at (217)333-0489, or send e-mail to d-lampe@uiuc.edu.

Other on-line resources for insect information include the College of Agriculture's Cooperative Extension Service home page, "http:www.ag.uiuc.edu/welcome.html", and the Illinois Natural History Survey home page, "http:www.inhs.uiuc.edu:70/".

Pesticide Applicator Training Workshops

In addition to the Agricultural Pesticides Conference, the UI conducts about thirty-three workshops each year for commercial pesticide applicators, and anywhere from 150 to 188 workshops each year for private applicators. The purpose of these workshops is to assist professionals in obtaining certification.

Anyone who applies "general-use" pesticides commercially must be certified every three years. And anyone who applies "restricted-use" pesticides — even on their own property — must be certified, says Phil Nixon, UI Extension entomologist and pesticide training specialist. Many common insecticides used by farmers fall under the restricted-use category.

In 1993, Nixon says he and his colleagues trained more than ten thousand people in the private applicator training workshops and more than seven thousand in the commercial applicator workshops.

Crop Protection Workshop and Field Crop Pest Management Short Course

The annual Crop Protection Workshop is an in-depth, two-day event that covers the biology, identification, and management of insect, weed, and disease pests in Illinois.

The workshop attracts about three hundred people each year, most of them crop consultants, agronomists, agrichemical representatives, soil conservationists, farmers, Extension educators, pesticide dealers and applicators, seed company representatives, and anyone else interested in agriculture and environmental issues.

One unique feature of the Crop Protection Workshop is that participants can tailor their schedule to zero in on a few specific pest problems, says Mike Gray, a UI Extension entomologist and workshop coordinator.

For those more interested in a snapshot look at a wide variety of pests, rather than an in-depth examination of one or two pests, UI also offers a Field Crop Pest Management Short Course. This course serves as a good introduction for those who are new to agricultural consulting; it is also a good refresher course for veterans.

Crop Diagnostic Training and Research Center

On 20 acres in Indiana, they're intentionally infesting agricultural fields with insects. But it is not the work of entomological terrorists. It is routine at Purdue University's Crop Diagnostic Training and Research Center, where UI and Purdue specialists conduct hands-on workshops for professionals who work with farmers.

During these one-day workshops, agriculture professionals roll up their sleeves and venture into the 20-acre outdoor laboratory, says Gray. In the fields, they learn how to identify pests and pest damage, and they sharpen their crop troubleshooting skills.

"For example," Gray says, "we might infest the plants with European corn borer larvae. Then we take participants into the field, talk about the biology of the insect, and explain how to scout for the pest."

After participants break into smaller groups and arm themselves with calculators, they try their hand at estimating pest populations. They ultimately must decide: Based on these numbers of pests and other economic factors, should they treat with insecticides?

Insects and People

This brings us full circle back to May Berenbaum, who teaches one of the more popular entomology classes on the Urbana campus — "Insects and People." Berenbaum's course takes a broad look at how people and insects have interacted over the centuries, covering everything from insects in laboratories to insects in literature.

The course includes a honey biochemistry lab, where students measure the chemical and culinary attributes of honey; an aquatic biology lab, where they learn how to design an insect that can survive in an aquatic environment; and a forensic entomology lab, where they find out how insects can help determine the time of death. (Hint: It has something to do with maggots.)

In the silk lab, students unreel a silkworm cocoon, which consists of a single strand of silk one-half mile long. And in the edible insect lab, they create stir-fried silkworm pupae, as well as maengdana, a chili paste made from giant waterbugs.

DAVID RIECKS

Students in the University's "Insects and People" class examine insects' form and structure.

If expecting students to eat their homework in the edible insect lab sounds like cruel and unusual punishment, Berenbaum says to keep in mind that insects are not only nutritionally and economically suitable as a food source but also constitute part of the regular diet in many regions of the world.

According to Berenbaum, "Worldwide the most commonly consumed insects are those that are available in large quantities — specifically, migratory locusts or social species such as termites."

In the words of Alexis, the third-century Greek poet:

> For our best and daintiest cheer
> Through the bright half of the year,
> Is but acorns, onions, peas,
> Ochras, lupines, radishes,
> Vetches, wild pears nine or ten,
> With a locust now and then.

Doug Peterson, Extension communications specialist, Office of Agricultural Communications and Education

Honey Bees: Unlocking the Secrets of Colonial Rule

Gene E. Robinson

A honey bee sipping nectar from a flower in a garden, orchard, or field is a sight familiar to most of us. However, honey bees are not native to North America — they were brought to the continent by European settlers beginning in the 1600s. According to Professor Elbert Jaycox, an apiculture specialist retired from the University of Illinois, honey was so prized by early settlers of the Midwest that people even fought over it. The mercifully brief "Honey War" apparently started after a Missouri farmer cut down a few trees housing bee colonies packed with honey — on land also claimed by Iowa.

Honey continues to enjoy strong consumer demand, but honey bees now play a central role in U.S. agriculture primarily because of their pollination activities. Many of our nation's crops, including some grown in the Midwest, such as apples, alfalfa, and sunflowers, depend on insects to transfer pollen from one blossom to the next for high yields. According to a recent study conducted at Cornell University in New York, the value of crops that require insect pollination has been estimated at $10 billion. And honey bees are the premier insect pollinators of these highly valued crops.

Courtesy Agricultural Research Service-USDA

Courtesy Gene Robinson

UI bee expert Gene Robinson, top, examines the health of a hive and smells for bees releasing pheromones, chemical agents used for communication.

A bee researcher, left, places a powder containing biocontrol bacteria into a tray for dissemination by the honey bees.

Growers "rent" honey bees from beekeepers because they can be easily transported to the farm, by the millions, precisely when a crop is in bloom. Honey bees work relentlessly from dawn to dusk pollinating, though their behavior is actually motivated by the simple need to gather as much food as possible to feed the thousands of hungry mouths back at the hive.

The Cornell study also reported that recent changes in the U.S. diet have led to substantially higher production and consumption of many crops that rely on bee pollination. This trend is predicted to continue, especially for fruits and vegetables — so honey bees will assume even greater economic importance to agriculture.

How ironic, then, that while honey bees are becoming increasingly important, the U.S. beekeeping industry faces three grave threats. First, its profitability is being undermined by very low world honey prices, a consequence of "dumping" practices by some countries, according to several economists. Second, the recent introduction of two parasitic mites, *Acarapis woodi* and *Varroa jacobsoni*, has resulted in decreased colony productivity and the deaths of hundreds of thousands of colonies. Third, Africanized (alias "killer") bees have entered the United States from Latin America. Because they defend their hives more vigorously than do their European counterparts, Africanized bees are more difficult to manage for either honey production or pollination.

Of these three threats to the beekeeping industry, the first is economic and political. The second and third problems, however, are biological. The ability

of beekeepers to continue working with strong and manageable colonies of bees, despite these problems, will play a crucial role in determining whether enough bees are available to meet the current and future pollination requirements of U.S. agriculture.

Current bee research in the United States addresses both short-term and long-term concerns. Fundamental questions of basic bee biology are being studied at the UI Bee Research Facility. To maintain and increase colony productivity over the long term, I believe, we need to learn more about the physiological and genetic mechanisms that regulate honey bee social order, especially the colony's elaborate division of labor. Improved knowledge of hormonal and neurobiological factors that regulate bee behavior may lead to new techniques for manipulating the division of labor to improve colony performance for honey production and pollination. Understanding the genetic basis of bee behavior may lead to improved breeding programs to produce less defensive and more productive stocks of bees.

A number of research projects are under way at the Bee Research Facility to reveal bee secrets.

Flexibility in Honey Bee Career Choices

At the heart of colony organization is an age-based division of labor among the worker bees. A honey bee colony typically consists of reproductives — a single long-lived queen and anywhere from zero to several thousand drones — and tens of thousands of workers that perform all tasks related to colony maintenance and growth. Workers generally labor in the hive for the first two to three weeks of adult life; then they forage, gathering food outside the hive, for the next — and final — one to three weeks of their life.

This pattern is not written in stone, however. Bees can accelerate, retard, or even reverse the aging process on demand. For example, a surge in worker birth rates, due perhaps to favorable environmental conditions in late spring, may soon result in a colony that has too few foragers to handle the food demands of all the new young bees. Under these circumstances some young bees shorten dramatically their tenure as hive bees, from three weeks to one, and become "precocious foragers."

How can a young bee, in a society of more than 40,000 individuals performing a dozen or more tasks simultaneously, "know" that there is a shortage of foragers and change its occupation accordingly? It is inconceivable that each individual bee can monitor the state of the whole colony and then perform the tasks that are needed most. Another challenge to our understanding is that a honey bee colony apparently governs itself in a way alien to us — it functions without centralized government. There is no evidence of colony leaders — even the queen does not appear to direct worker bees from one task to another. It is necessary to solve the puzzle of how a colony can reassign its workforce in the face of changing conditions if we are to have any chance of someday manipulating the division of labor to increase pollination efficiency.

Research at the Bee Research Facility is probing mechanisms that underlie this remarkable behavioral flexibility. Scientists have discovered that juvenile hormone (one of the most important hormones influencing insect development) acts as a behavioral pacemaker in honey bees. Indirect evidence of its role can be found

Xenophon recounts the experience of 10,000 Greek soldiers returning with Pompey from Persia. Heptakometes, the leader of the opposition, poisoned Pompey's soldiers by setting out hives filled with honey made from rhododendron flowers. Rhododendron nectar contains a substance called andromedotoxin, a potent toxin. The soldiers, unable to resist such a treat, consumed a sufficient amount to induce "such terrible vomiting and flux that they were unable to stand."

Courtesy Gene Robinson

Gene Robinson demonstrates the installation of a new colony to students in his beekeeping class.

Researcher Gene Robinson observes the behavior of bees inside a "flight chamber." This particular hive contains a colony of approximately 50,000 bees.

DAVID RECKS

in the fact that hive bees have low levels of this hormone, and foragers have high levels. Direct proof has also been obtained: young bees given hormone treatments become precocious foragers.

Manipulating hormone levels on a bee-by-bee basis is one thing. Demonstrating that the bees alter hormone levels themselves in response to changing conditions is another. To do this, Robert Page of the University of California–Davis, Colette Strambi and Alain Strambi of the Centre National de la Recherche Scientifique in Marseilles, France, and I induced precocious foraging by establishing colonies that consisted initially of only very young bees. Then, testing for blood levels of juvenile hormone, we found that one-week-old precocious foragers have levels higher than those of one-week-old hive bees, but about the same as those of three-week-old foragers.

Building on these results, research associate Zhi-Yong Huang and I studied how bees actually acquire information on changing colony conditions. Using techniques inspired by developmental biology reminiscent of cell culture and transplantation (but manipulating organisms within a colony rather than cells within an organism), we demonstrated that bees are influenced by contacts with their hivemates and not by assessing the contents of the hive. This was shown by transplanting a group of foragers to a colony that consisted initially of only very young bees.

The transplant inhibited precocious foraging, even when the hive entrance was closed to prevent transplanted foragers from bringing back fresh nectar and pollen from outside. If the resident bees had been influenced by the hive, rather than by the foragers themselves, they should have developed into precocious foragers because of the lack of fresh food.

A further indication that foragers inhibit the aging of younger bees was revealed when we reared individuals in isolation in the laboratory for seven days. In the absence of older bees, isolated individuals had precociously high levels of juvenile hormone, and when placed into a colony they even acted as precocious foragers.

Based on these results, we developed a model proposing that the time it takes for a bee to grow up is regulated by the interplay between an "activator" and an "inhibitor." Juvenile hormone appears to activate behavioral development in honey bees. We are actively searching for an inhibitor; recent unpublished results suggest that there must be direct, bee-to-bee contact for the inhibitor to be spread. This raises the possibility that the inhibitor is a "contact pheromone" (a chemical mediator of behavior). Identifying this factor and further elucidating the activator–inhibitor model will help us understand how a bee adjusts its career choices to best serve the colony.

Africanized Bees

New strategies are needed to ameliorate the defensive behavior of Africanized bees. UI researchers have begun basic research on the physiological underpinnings of differences in the behavior of Africanized and European honey bees. Earlier research by Mark Winston of Simon Fraser University in Vancouver, British Columbia, suggested that Africanized bees grow up more rapidly than do European bees. Using European bees, student Tugrul Giray and I have confirmed that differences in rates of behavioral maturation do have a genetic basis. Employing colonies composed of bees with genetic markers, we have learned that some strains grow up more rapidly than others.

Working in Mexico with Ernesto Guzmán of the Universidad Nacional de México, Giray and I have begun to determine whether differences between Africanized and European bees in rates of behavioral maturation are due to differences

Bee Lab Abuzzzz with Activity

Tucked next to a pocket of prairie on the so-called South Farms research plots sits a modest building with a few short towers of wooden boxes standing about in the grass. Here at the University of Illinois Bee Research Facility and eight other area apiaries, or beeyards, the behavior of millions of honey bees is being scrutinized and manipulated. The hope is that discoveries about how the bees organize their work will one day enable scientists and beekeepers to improve bee productivity.

The "bee lab," one of just twenty or so such facilities in the country dedicated to honey bee research, is a relative newcomer to campus. When Professor Gene Robinson was hired by the University's Department of Entomology in 1989, such a lab was a prerequisite for his work. The South Farms building was made available, and Robinson and technician Jack Kuehn set about outfitting the new lab.

Kuehn traveled throughout Illinois to find and buy colonies of bees from "sideliners," beekeepers who maintain a limited number of hives. A key selection criterion was that colonies be free from disease and from two species of destructive parasitic mites. The mites, though only patchily present in the state then, have in just five years become a serious problem in Illinois, as they already were in much of North America and the world.

The number of hives kept by the lab fluctuates between seventy-five and a hundred, with the highest populations in summer, when colonies are strong and bees are actively at work. In spring, after the queens have laid eggs, lab workers transfer the bee pupae to a temperature-controlled incubator one day before the pupae emerge as adults from their wax-capped cells. When they are a day old, these new adult bees, which cannot yet fly or sting, are put into a shallow bin. Each is picked up and marked — with paint or even a tiny numbered badge — according to the needs of the research under way.

The young bees might also get treated at this stage, perhaps with a hormone or neurochemical. Then the bees are placed in a hive, either outside or in one of the lab's observation spaces — thin, glass-walled structures that allow the activity inside to be easily monitored. Queens are typically artificially inseminated in the lab to control the genetics of the resulting bees.

Like the bee populations, the number of people working with them is highest in summer: typically five to seven graduate students and five to ten undergraduates assist with the work, along with postdoctoral researchers. Bee research dovetails unavoidably with beekeeping, and students who work with Robinson and Kuehn become adept at managing colonies. One student has already gone on to teach beekeeping with the Peace Corps in Ghana, West Africa.

One other activity keeps the bee lab busy in late summer — answering calls about local bee problems. Honey bees actually almost never go after picnic food. That pest trying to crawl into your soda can is probably a wasp instead. — *Molly Bentsen, publications editor, Office of Agricultural Communications and Education*

in their activator and inhibitor mechanisms. Recent unpublished results indicate that Africanized bees indeed grow up more quickly and that these differences can be explained in terms of the activator–inhibitor model. We also have begun to explore the intriguing possibility that differences in rates of behavioral maturation are related to differences in defensive behavior. Because older bees are more defensive than younger bees, it stands to reason that a colony of faster maturing bees might be more defensive than a colony in which bees grow up more slowly. It is hoped that these two studies together will provide fundamental knowledge useful for developing novel control strategies for Africanized bees.

Applied and Basic Research: A Lesson from Reverend Langstroth

As in other areas of agriculture, beekeeping has benefited tremendously from a healthy mix of applied and basic research. In fact, the practice was revolutionized by an observation of basic bee biology in 1851 by Reverend L.L. Langstroth, an amateur beekeeper from Philadelphia who documented his avocation in personal journals and a published instruction book.

Before Langstroth, beekeeping was a primitive affair. Honey harvesting often resulted in the death of the colony, because bees affixed their honeycombs firmly to the walls of the tree or skep (a beekeeping basket) in which they lived. Langstroth observed that there is always ¼- to ⅜-inch space between the honeycombs that bees build. He created a beehive with movable frames of honeycombs by ensuring that the combs were separated from the hive walls by this precise "bee space." Beekeepers were for the first time able to harvest honey without killing the bees and damaging other parts of the hive, thus greatly increasing productivity. The honey bee's vital pollination services may be further enhanced by future insights into bee behavior.

Gene E. Robinson, University Scholar and associate professor, UI Department of Entomology

Size Isn't Everything: Insects as Powerful Vectors of Disease

Tina M. Prow

When seven whooping cranes died a decade ago at the Maryland Wildlife Research Center, researchers traced the cause to mosquitoes. Mosquitoes had transmitted eastern equine encephalitis to the endangered species.

Once researchers identified the disease in whooping cranes, they captured and vaccinated adult birds. Young birds, which cannot be vaccinated, remain at risk.

Mosquitoes also are linked to lethal disease in other birds, such as sandhill cranes and scrub jays.

"These cases and many others show why we are still concerned with the mosquito as a nuisance and a transmitter of diseases that impact man and animals," says Robert Novak, a medical entomologist with the University of Illinois and Illinois Natural History Survey. Novak specializes in mosquito ecology, control, and surveillance and focuses his research program on mosquito management for protecting public health. Last year, he broadened his program to include wildlife, a move that fits the human health focus.

"When you think about the impact of these pests on an endangered species like the whooping crane and the possible long-term effect on other birds and animals, it's like a two-by-four to the head of a mule — if we look at pathogens in a preventive mode at the wildlife sector, it may be possible to interdict early. Why wait until we get human cases of disease? Why wait until an endangered species dies out?"

Human Ailments Brought by Insects

According to the National Academy of Sciences, eighteen of fifty-two infectious diseases of humans are insect-borne. Of those, sixteen are transmitted by mosquitoes. "The threat is there and increasing as the globe shrinks — as we move things and people so rapidly that there are virtually no quarantine periods," Novak notes.

Petroleum-based insecticidal oil products, such as No. 2 diesel oil, have been the mainstay for control of mosquito larvae in a variety of wetland habitats. These products coat the surface of water and suffocate larvae. "They work, but we are concerned about what petroleum-based products do to plants and aquatic life," Novak says.

One of Novak's most recent projects may provide an alternative to petroleum-based products and an alternative market for soybean producers. Collaborating with UI researchers David Seigler, a natural product chemist, and Robert Metcalf, an entomologist-toxicologist, Novak is looking at the potential for using soy oil products for mosquito control.

Soy oil appears promising because it is biodegradable. Furthermore, researchers are looking for a formulation that will break down quickly — in twelve to twenty-four hours. They will study how soy oil breaks down in the environment and what effects, if any, it has on plant and aquatic life.

Researchers also will look at the potential for soy oil to carry pathogens that could kill mosquitoes not suffocated by the oil. A soy-oil product might also carry other biological control agents that are toxic to or repel or attract mosquitoes.

"There are many neat things about this oil and a plethora of things we could look at. For instance, if secondary compounds that have insecticidal properties could be added to the oil, it could allow a holistic approach to pest management," Novak says.

Despite excitement over the possibilities, however, the team is starting at the

beginning, he adds. That is, they are reviewing research literature and screening formulations of soy oil to find an oil that spreads as desired and degrades quickly. They also plan to look at the effect of different doses and formulations on the larvae of "bad-news mosquitoes," those that carry malaria and other diseases. The team will assess toxicity to plants and aquatic life.

"We'll do a lot of laboratory work before we move into controlled field experiments," Novak says. "One of our goals is

to gain as much information as necessary, which then could be used for registration by the Environmental Protection Agency."

The research has potential applications beyond mosquito control, Novak notes. If successful, soy oil products could be used to control whitefly in greenhouses, borers in orchards, and other pests managed with petroleum-based insecticidal oil products.

Insects Can Transmit Disease to Crops, Too

Farmers contend not only with insects that feed on their crops but also with the diseases they spread. Aphids, leafhoppers, whiteflies, and several beetle species are among the most common carriers of disease pathogens in Illinois.

Cathy Eastman and Michael Irwin, entomologists with the University of Illinois and Illinois Natural History Survey, are studying barley yellow dwarf disease. Eastman ranks this disease of wheat, oats, and other small grains among the most important of plant diseases worldwide. Barley yellow dwarf virus strains are most commonly transmitted by certain species of aphids that can carry the disease into a field from as far away as the southern United States or as nearby as a neighboring plant.

"Barley yellow dwarf causes a sizable dollar loss to crops. Estimates from Indiana suggest 10 percent of losses in wheat are attributable to barley yellow dwarf," Eastman says.

Yellowing, stunting, poor grain production, and winter kill of plants with affected root systems are symptoms of barley yellow dwarf. However, these symptoms may be nondescript in wheat or may mimic nutrient deficiencies. As a result, barley yellow dwarf may go unrecognized in fields every year, Eastman says.

Eastman and Irwin's barley yellow dwarf research, conducted in cooperation with the UI Department of Plant Pathology and U.S. Department of Agriculture, as well as with the Natural History Survey, focuses on the epidemiology of the disease. Researchers are looking for clues to how aphids pick up the disease and then transmit it. They also are looking for factors that influence spread through a field.

The role of perennial grasses and grassy weeds as a reservoir for the virus is one aspect of the research. Eastman's team inoculated mini-plots with the virus and sampled them over time. Molecular biology techniques will allow the researchers to assess whether the strains of virus they detect are those they introduced or are those brought in by migrant aphids. From this study, the team hopes to determine how important local plants are as a reservoir for barley yellow dwarf.

A second phase of the project involves planting a spring oats–grass–wheat rotation. Researchers are sampling for presence of barley yellow dwarf virus and looking at the dynamics of aphid populations over time. This research may yield information on the role of grasses in disease spread and factors that set off an epidemic.

DAVID RECKS

Culex molestus *mosquitoes feed on the arm of medical entomologist Robert Novak.*

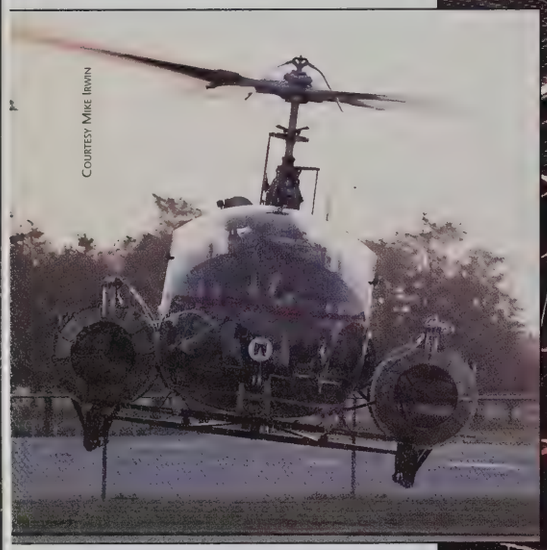
The Ins and Outs of Insect Flight

One key piece of information for managing aphids and other migratory insects is knowing when they are likely to show up. Michael Irwin's research in aerobiology, or insect flight, is a step toward developing an early forecast system.

"It is practical," he says. "The lack of research on how insects move is a major bottleneck, but researchers are finding ways to share technology and information across projects so that the costs will be more reasonable. Eventually, we will characterize the movement of weekly flying insects, such as aphids."

Irwin and his UI colleagues Scott Isard and Gail Kampmeier are part of the Alliance for Aerobiology Research, a national group of scientists coordinating plans to foster an integrated, multidisciplinary approach to research on how insects migrate and disperse. Irwin's pioneering research on the mechanics of aphid flight began more than a decade ago. Among the aphids that interest him are species that transmit soybean mosaic virus.

"We see soybean mosaic virus epidemics in this area when the aphids arrive at just the right time. If we imported seed that carried inoculum or if aphids native to China got in, we'd see a lot more of it," he says. "It behooves us to be prepared — if we don't know the mechanics of the causes, it will be hard to know how or when to intercede."



A helicopter takes off with two large pods attached for collecting insects for research on insect flight.

At right, Mike Irwin (left) and Scott Isard of the Illinois Natural History Survey study flight patterns of aphids in a wind tunnel they constructed.

In Illinois, many of the most economically important species of aphids die out over the winter. Yet they are back each growing season, arriving on wind currents along with other insects, including the black cutworm and potato leafhopper.

To track aphids, Irwin collaborates with scientists having expertise in insects, diseases, engineering, crop development, and weather. For a 1984 project focused on corn leaf aphids, the scientists collected aphids in sampling "pods" attached to helicopters.

Since then, they have used radar to detect aphids in various air currents that move them from the Gulf of Mexico to Illinois and even farther northward. The scientists have tethered the tiny aphids and put them in a wind tunnel to measure use of energy in flight. Computer modeling has proven to be an important tool for studying population dynamics.

As a result of the broad collaboration, scientists can catch an aphid high in the air and determine how long it has been flying and where it came from. They know that aphids land only if they can see the ground. So if the aphids get caught in a wind current at night, they are likely to continue flying until daylight. Aphids are not distributed randomly through the air. Instead, they form layers in the air currents. Some are predisposed to flapping their wings and moving up into higher air currents, whereas some are not.

Aphids of different genetic backgrounds may travel together. In different years, researchers found, aphids invaded Illinois from different places. Irwin also notes that aphids ignore international boundaries. Studies show that aphid genetics are not consistent, which suggests there is no permanent source of aphids, at least not within the United States.

Studies using helicopters to sample aphids in different atmospheric conditions indicate temperature is a factor governing their distribution in the air. Strong night currents will move some aphids from the Gulf into Illinois, depending on where they are in the atmospheric layers. They land in waves throughout the season, arriving much like troops on a beachhead. Once a wave arrives, the aphids will move in a field but will not catch another air current.

"Now we can predict how far aphids go in the night and what level they will be at," Irwin says. "Understanding the whole system makes an areawide integrated pest management approach for controlling aphids feasible."

Tina M. Prow, science writer, Agricultural Experiment Station

Biological Pest Control: Good Guys vs. Bad Guys

Tina M. Prow

In an effort to reduce the amount of synthetic chemical pesticides used in crops and gardens, researchers are looking more closely at a strategy Mother Nature uses to keep pests in check — natural enemies.

Almost all pests of field, horticultural, and ornamental plants have natural enemies, according to Robert Wiedenmann, an entomologist with the University of Illinois and Illinois Natural History Survey. Wiedenmann is a member of the Ladybird Committee, a group of Midwest biological-control scientists whose emblem is the ladybird beetle, or ladybug. Wiedenmann and his colleagues not only are working on ways to make better use of the natural enemies that kill pests of important agronomic crops but also are taking steps to teach farmers, gardeners, and consultants how to use biological controls as a pest management option.

"There is some uncertainty associated with biological control," Wiedenmann acknowledges. "It may work one year and not the next, or it may work in one habitat and not another. But that doesn't mean the approach should be condemned."

In fact, he points out, biological control has a longer history as a pest management strategy than synthetic pesticides. Centuries ago, Chinese farmers used ant nests from the countryside to control certain orchard pests. When California's citrus groves were threatened in the 1800s by cottony cushion scale, an entomologist searched its native habitats in Australia and New Zealand for an enemy. He sent back the vedalia beetle, which brought cottony cushion scale under control.

Since the 1940s, many farmers have relied on synthetic chemical pesticides to manage pests. More recently, however, concerns about the risks synthetic chemical pesticides may pose to human health and the environment are causing farmers, regulators, and scientists to take a harder look at biological control.

"The problem of ag chemicals in groundwater is a serious and growing concern," Wiedenmann says. "In addition, many pest problems in agriculture aren't solved by pesticides but are in some cases *created* by pesticides."

For instance, chemical pesticides that eliminate insects, including natural enemies, actually can cause certain pest populations to explode. In contrast, the intent of biological control is not to eradicate pests but to keep pests at low enough levels that they cause little harm to the crop. After all, some levels of pests are required for the populations of natural enemies to feed on, Wiedenmann points out.

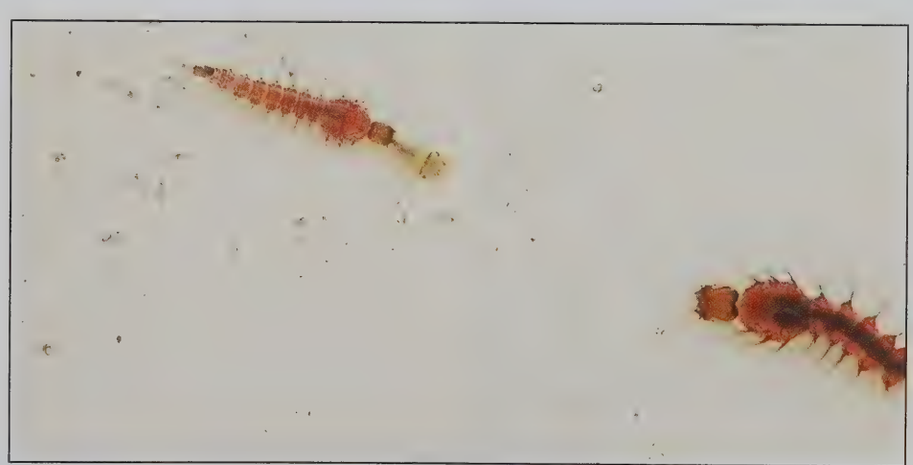
Another problem with synthetic chemicals is that the cost of developing and reregistering products soon may leave farmers with only broad-spectrum pesticides. These kinds of pesticides are more likely than others to cause resistance.

"There is potential for increased use of biological control to manage certain pests effectively without the risks we have from ag chemicals," Wiedenmann says. Biological control, he suggests, can fit into any integrated pest management program — and likely already is a part of many.

Beneficial Insects: The Good Guys

Illinois farmers see biological control, compliments of Mother Nature, at work almost every year in alfalfa fields when the fungal pathogen *Zoophthora phytonomi* and parasitic wasps wipe out the alfalfa weevil population.

Four broad groups of beneficial natural enemies control pest insects: predators, parasites, nematodes, and pathogens.

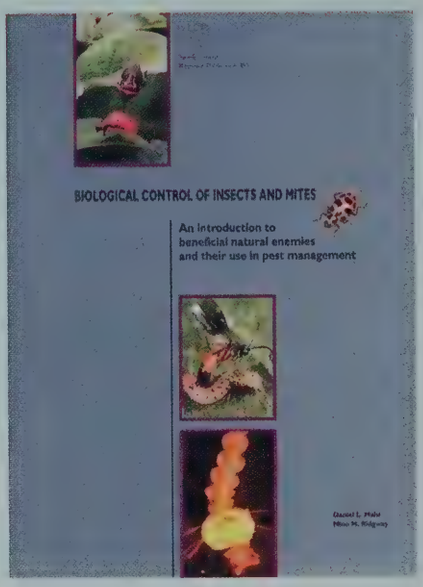


DAVID RECKS

A Toxorhynchites mosquito larvae feeds on a Culex pipiens *(northern house mosquito) larvae. The* Culex pipiens *is known to transmit St. Louis encephalitis.*

New Resource on Biological Control

"Remember: many insects in a crop or garden are beneficial or are merely transients with no particular impact on the crop," say Daniel L. Mahr and Nino M. Ridgway, authors of a book on biological control published by the University of Wisconsin. Their book, *Biological Control of Insects and Mites: An Introduction to Beneficial Natural Enemies and Their Use in Pest Management*, is 92 pages long, with an index and color photos. It is available for $14 from the Office of Agricultural Communications and Education, 67-IR Mumford Hall, 1301 W. Gregory Drive, Urbana, IL 61801, (217)333-2007. Ask for North Central Regional Publication 481.



About one hundred types of predatory and parasitic insects, along with a variety of insect-parasitic nematodes and insect pathogens formulated as microbial insecticides, are commercially available.

The ladybird beetle is an example of a predator. Among its prey are aphids, scale insects, and white flies.

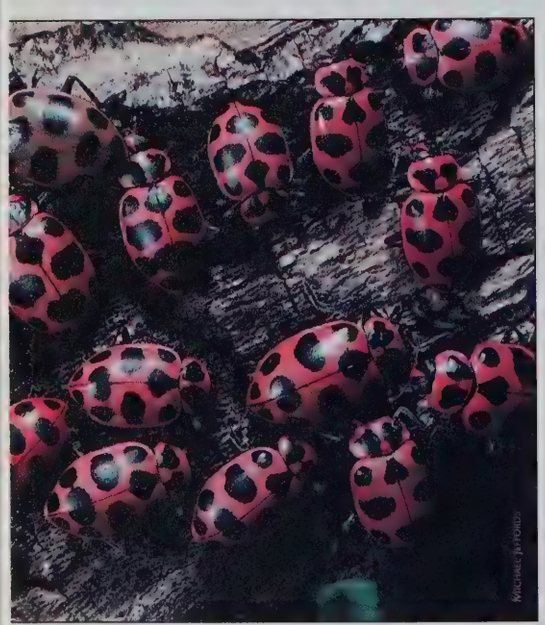
Parasites lay their eggs in or on pests. Later, the larvae from these eggs feed on the pest. Parasitic wasps kill a host of pests, including caterpillars, weevils, greenhouse whitefly, and moth eggs. These wasps are different than stinging wasps that chase people from picnic areas; those in Wiedenmann's laboratory are smaller than the period at the end of this sentence.

Nematodes, which are tiny worms, kill several soil insects. A few types are mass-produced and sold for pest control.

Pathogens include bacteria, viruses, protozoans, and fungi, which act as lethal diseases in certain insects. *Bacillus thuringiensis*, or *Bt*, for example, kills caterpillars, some beetle larvae, and mosquito larvae. Several strains of *Bt* are marketed for insect control.

"The action of biological control on enemies is very specific," Wiedenmann says. "People who are interested in biological control must buy or look for the very particular natural enemy that preys on the very particular problem pest they have."

Researchers conduct extensive laboratory and field tests to find which biological control agent might work against a certain pest; why it works or fails; and against which other insects the control agent might be effective. They take three approaches to biological control.



Ladybird beetles, or ladybugs, are important "good guys" in the fight to control crop pests.

Creating an Attractive Home for Beneficial Insects

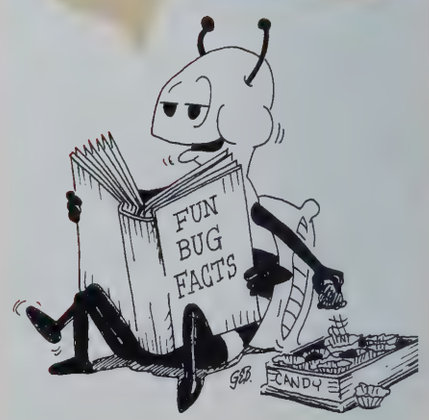
One approach to biological control is to manipulate the habitat to allow natural enemies that are already in a field to thrive. For instance, vegetation around a field may provide a habitat for ladybird beetles, minute pirate bug, spiders, and other predators. Row crops are especially unfriendly to many natural enemies of crop pests, Wiedenmann says.

"Much of the research with species that might control European corn borer has been unsuccessful," he says, "possibly because the corn environment simply doesn't provide a friendly habitat for these natural enemies."

Another approach is to augment the population of natural enemies by adding to what is there. For example, *Trichogramma* wasps in seed corn appear to be as functionally effective and cost-effective as chemical pesticides for controlling European corn borer.

"The intention with this strategy is not to establish a permanent population. In most cases, natural enemies would not overwinter," Wiedenmann says.

Martin Lindauer, a famous bee biologist, has discovered that the image of the "busy bee" is something of a myth. Through careful observation, he concluded that, while bees do perform many different duties during the course of their adult life, they spend most of their time — up to 70 percent — hanging around the hive, just resting.

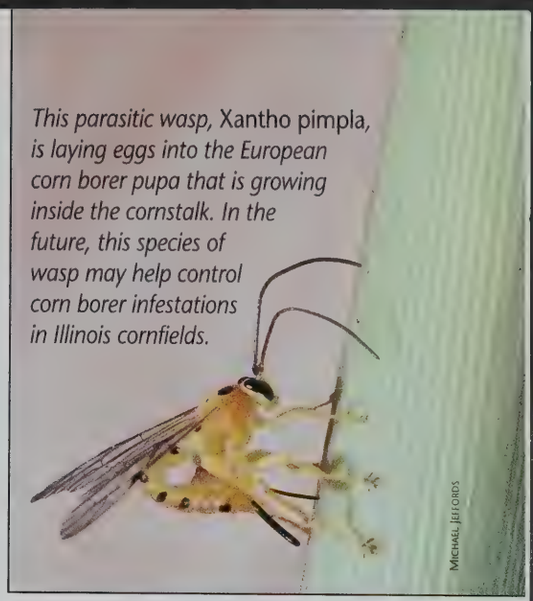


In contrast, a third approach to biological control is to bring in a natural enemy from elsewhere and release it for permanent establishment. About three-quarters of the field-crop pests are exotic, notes Wiedenmann. They often are a problem because they arrive here without natural enemies.

"The idea is to return to the original home of the pest, determine what natural enemies were keeping it in check, and import a potential enemy to the United States to study," he says. The research on any imported biological control includes quarantine and extensive studies to ensure the natural enemy is an enemy of the target pest and not of Aunt Martha's tomatoes.

"The safety record is good," Wiedenmann says of this research. "Historically there are almost no recent examples of biological control agents having a bad effect or an impact on nonhost plants."

One of Wiedenmann's current projects is to find parasites of stalk-boring insects, such as the European corn borer. Japan, Pakistan, and East Africa have provided several parasites of corn borers, but their eggs do not hatch on European corn borer. Wiedenmann wants to know



This parasitic wasp, Xantho pimpla, *is laying eggs into the European corn borer pupa that is growing inside the cornstalk. In the future, this species of wasp may help control corn borer infestations in Illinois cornfields.*

MICHAEL JEFFORDS

Farmers Help Solve Pest Management Problems

As the eastern sky begins to glow on a crisp, fall morning, farmer John Smith gets ready for another day. He checks the combine and pulls the grain carts out to the field. But before today's harvesting begins, there's a different kind of chore he needs to do — data collection.

Nowadays farmers are doing more than farming. In addition to the tractor and hoe, farmers are taking up the clipboard and computer. They are using their farms as living laboratories to conduct what has come to be known as on-farm research.

On-farm research isn't new. Farmers have always "experimented," but much of today's on-farm research is substantially more technical than the side-by-side comparisons Grandpa use to fiddle with on the back forty. And we're not talking about a university researcher using the farmer's field to do university research. On-farm research today involves farmers working in partnership with university researchers using legitimate research methodology to test ideas for developing farm operations that are environmentally friendly and financially profitable.

Why should farmers do research on their farms? Isn't that the job of the land-grant university?

Land-grants have succeeded in developing the most productive food production system in the world. But the very system that has given us abundant, affordable food has also created problems that could threaten our ability to sustain a healthy, abundant food supply for the world population. Many in the land-grant system recognize the need to address these issues. Farmers, too, are becoming aware of problems as they come under fire from environmentalists for certain farming practices.

As end users of land-grant research, farmers need to be closely involved in the process of finding solutions to today's agroecological dilemmas. Researchers working in partnership with farmers are discovering the wealth of experiential knowledge farmers possess after generations of working with the land. At the same time, farmers are helping researchers apply scientific knowledge in ways that are practical and useful in the real world.

Mike Gray and Kevin Steffey, agricultural entomologists at the University of Illinois, are working with twenty-nine farmers on a two-year project to develop a method to determine the need for pesticide use in continuous corn. Even though research has shown that pesticides are not necessary every year in every field of continuous corn, farmers apply it routinely in those situations.

"Most studies show that an accurate count of the adult rootworm beetles can predict the extent of the damage in continuous corn the following year," Steffey says. The problem is, farmers aren't taking the time to count, or they don't feel confident when they do.

The entomologists are providing tools and training the farmers in a new method for determining the severity of rootworm infestations. As one part of the project, the farmers set out traps, replaced them weekly, counted the trapped beetles, and mailed the data in to Gray and Steffey. The scientists followed up by visiting the fields and assessing root damage in an attempt to correlate it to the beetle counts supplied by the farmers.

This kind of collaboration with farmers is the best way for researchers like Gray and Steffey to develop practical methods for improving pest management on the farm.

— Daniel Anderson, on-farm research coordinator, Agricultural Experiment Station and Cooperative Extension Service

Cool Tactics for Managing a Hot Crop's Pests

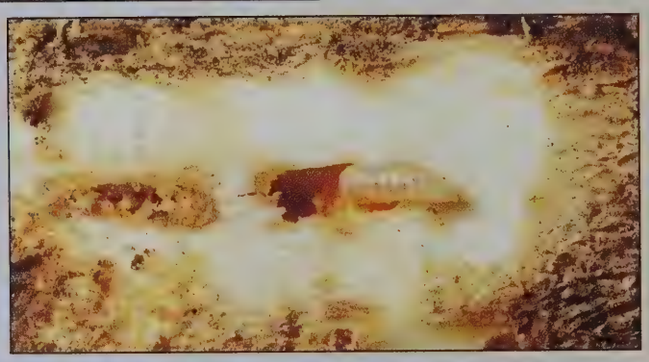
Illinois may be good at producing corn and soybeans, but it is tops at producing a lesser known but no less tasty crop — horseradish.

Illinois leads the nation in production of this fiery root. The state's horseradish is grown mainly on 1,200 acres in the "American Bottom" floodplain area of Madison, St. Clair, and Monroe counties (in the Mississippi River Valley near St. Louis), where it has been a valued specialty crop since the turn of the century.

David Voegtlin, Illinois Natural History Survey

A perennial crucifer grown commercially as an annual, horseradish is an unusual crop. Hand labor is needed throughout production. Secondary roots saved from the grower's previous crop provide the planting stock. The growing season is seven to twelve months, depending on market conditions. It is a dominant weed in rotation crops because it can sprout from root pieces buried deep underground.

Dan Sherrod, Illinois Natural History Survey



The crop's availability year-round makes horseradish quite a challenge for insect pest management. Research and extension programs to improve methods of managing insect, disease, and weed pests of horseradish have been a unique part of the UI Agricultural Experiment Station and the Illinois Natural History Survey since the early 1930s.

Horseradish is attacked by several insect species, most of which are not native to this hemisphere. Studies by Illinois entomologists for nearly twenty years have made it possible to determine which species are truly pests. Today there are no insect pests on the crop that require treatment every year. There are several, however, that sometimes reach damaging levels on vulnerable stages of the crop's development.

Leading the list of horseradish insect pests are the imported crucifer weevil and beet leafhopper. Adults and larvae of the weevil, an introduced pest found in 1977, attack roots directly and can kill young plants or contaminate harvested roots if present in large numbers. The beet leafhopper was identified in 1980 as a vector of the spiroplasma causing brittle root, a devastating disease that has destroyed 60 to 80 percent of the Illinois crop during epidemics usually coinciding with drought. Several leaf-feeders are occasional pests, including diamondback moth larvae, flea beetles, and false chinch bugs, which can occur in huge numbers per plant during drought conditions but seldom produce more than minor frostlike damage.

Current pest management guidelines for growers of Illinois's hottest crop can be summed up with the words, "Keep cool — don't apply insecticides until there is a real need." Insect pests of this crop are sporadic and seldom require treatment, and overuse of insecticides can create additional pest problems. A hardy plant, horseradish can withstand nearly 50 percent defoliation without affecting yield.

The need for treatment to control the beet leafhopper (a migrant into Illinois) and other sporadic pests can be assessed by careful monitoring of insects present in individual fields. To this end, a pilot project between UI Cooperative Extension Service personnel and the consultant service Alvey Laboratories has resulted in a successful scouting program that provides specific pest information to participants and, through Extension advisories, shares leafhopper and disease findings with growers as a whole. These programs, backed by years of research, are helping to increase grower recognition of pest and beneficial insects and to reduce insecticide applications. — *Cathy Eastman, entomologist, Illinois Natural History Survey*

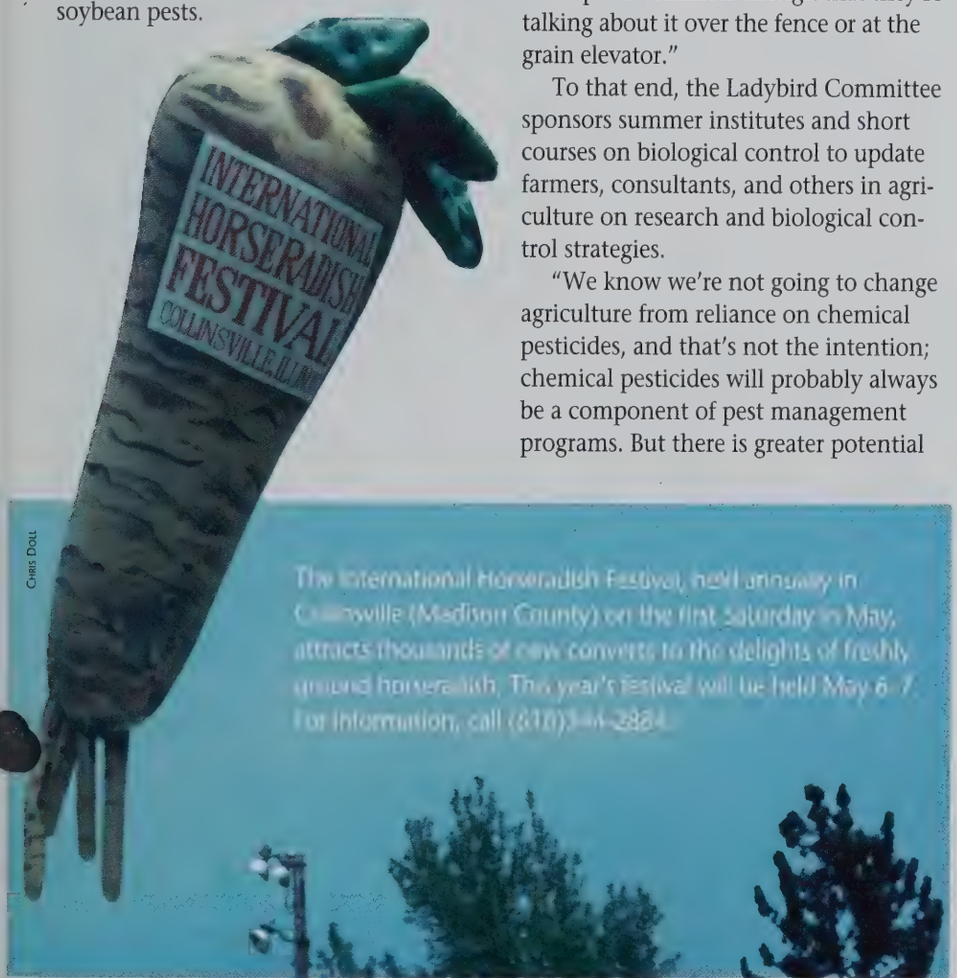
Cathy Eastman

The imported crucifer weevil adult, top, and larva, middle, kill horseradish by feeding on its roots. Fields of horseradish are a common sight in the Mississippi River floodplain near St. Louis.

why and continues to study the interaction. As a practical measure, however, he also is moving on to another potential biological control agent, this one from China.

"In the search for biological control agents, real opportunities and unimagined benefits come from looking at pests in the field — how they work, and how the crop is grown, and seeing what we might do to make an amenable environment," Wiedenmann says. "It's a way to narrow down and cut the probability of failure — and to make discoveries that you just can't anticipate."

Identifying potential biological control agents is only a first step — scientists follow up with laboratory and field research to understand as much as possible about the agents. For instance, one of Wiedenmann's students is "vaccinating" soybean with soybean mosaic virus to study the effect on the minute pirate bug. This insect feeds on soybean but also may be an important predator of soybean pests.



CHRIS DOLL

"How does the neatest thing since sliced bread affect other players? Does it create worse pest problems? Better predators? We need to ask these questions and have answers before we move forward," Wiedenmann says.

Practicing What They Preach

Research in biological control is not all "egghead science done in the laboratory," Wiedenmann says. Some projects have components that will be carried out by Cooperative Extension Service specialists working with growers. Involving farmers is a way to ensure success and to get more farmers thinking about using biological control agents as part of their pest management operations.

"Education about biological control increased adoption in Texas and California," he says. "We think more farmers in the Midwest will consider adding biological control to their management strategies when they are involved and when the topic is common enough that they're talking about it over the fence or at the grain elevator."

To that end, the Ladybird Committee sponsors summer institutes and short courses on biological control to update farmers, consultants, and others in agriculture on research and biological control strategies.

"We know we're not going to change agriculture from reliance on chemical pesticides, and that's not the intention; chemical pesticides will probably always be a component of pest management programs. But there is greater potential for biological control than I think some in agriculture realize. So the challenge is: What small and acceptable change is possible?

"That's why research is important. We've got to have evidence in order to recommend that farmers leave grassy strips that support natural enemies, or put out parasites when corn borer eggs are predicted to hatch. That's our job — to provide them with the information they need to make rational choices," says Wiedenmann.

Computer Modeling

An increasingly important tool for organizing information into a "representation of reality" is the computer model. A computer model can be constructed to help researchers home in on a researchable question and to help farmers weigh the consequences of pest management decisions.

Computer models are among the tools used to develop economic threshold calculations. These thresholds — often expressed as the number of pests present or the percentage of crop damage that will affect yields — are a cornerstone to integrated pest management strategies developed to promote judicious, effective, and safe use of pesticides on crops.

For instance, a model developed for European corn borer management resulted in a spreadsheet exercise in the *Illinois Agricultural Pest Management Handbook*, a 360-page book published annually by the Cooperative Extension Service. The spreadsheet leads growers through a set of equations related to the European corn borer population, yield loss, and economic considerations. Farmers can use the spreadsheet to determine whether the corn borer population warrants treatment.

Computer models typically are developed for pests of crops grown on a large number of acres or highly valuable crops. Alfalfa weevil, potato leafhopper, European corn borer, corn rootworm, and black cutworm are among field-crop pests researchers focus on in Illinois.

Tina M. Prow, science writer, Agricultural Experiment Station

Recording the Rich Natural History of Illinois

John Bouseman

When the early explorers and settlers entered the area destined to become the state of Illinois 250 years ago, they encountered a nature preserve 56,400 square miles in extent. Since then, much of the original natural diversity has been replaced by cultivated land, urban and suburban development, and a vast network of transportation.

Of the state's 36.1 million acres, some 33,356 acres are preserved and protected in the Illinois Nature Preserves System. This number amounts to less than one-tenth of a percent of the state's overall area.

Unfortunately, the diversity that existed in presettlement times cannot be known completely. But it seems likely that a substantial proportion of the species composition of the original fauna and flora remains here in diluted form in our system of nature preserves, state parks, and state forests, and in hilly terrain near waterways and in remnant wetlands.

Some former residents, such as the Carolina paroquet and the passenger pigeon, have of course vanished not only

David Riecks

John Bouseman searches the Illinois Natural History Survey Insect Collection to find a match for an insect that needs identification. A cypress swamp in Heron Pond, southern Illinois, is an example of a habitat that contributes to the natural biodiversity of the state.

from Illinois but also from the Earth. Others, such as the elk, the cougar, and the black bear, are gone from Illinois, and there is little likelihood that they could coexist with the state's human population if reintroduced. Some former inhabitants obviously are missed more than others. For example, few people would mourn the passing of the malarial agents from Illinois.

Contributing to the natural diversity found within the state are its mid-continental position and long north-to-south axis. There are tamarack bogs at the northern end of the state and cypress-tupelo gum swamps in the south. The central portion of the state was originally tall-grass prairie containing many western elements, and the remainder was largely in forest with strong relation to the eastern United States.

Putting Illinois Under the Microscope

The biota of Illinois has been the object of study by naturalists since the early nineteenth century. In those times the population of the state was sparse, and the investigators were often from institutions in the eastern United States or were amateurs from Europe.

Following the Civil War, the state's population rapidly increased. During the same period, institutions of higher learning were established, as were state agencies concerned with the natural history and geology of Illinois. Resident scientists began studying the natural resources of the state and assembling collections of animals and plants. These early generalists also began to shape the modern biological sciences of ecology, entomology, limnology, parasitology, and others.

In Illinois, the official state collections of plants and animals are housed in the Illinois Natural History Survey, located on the campus of the University of Illinois at Urbana-Champaign. Some materials incorporated in these collections date back to the 1870s. Such materials are, of course, irreplaceable. Groups of organisms represented by large state collections include vascular plants, fungi, mollusks, fish, reptiles, and arthropods, with insects

Insect Invaders

Illustration by Paula Wheeler

Humans are not the only highly mobile organism. Every plant or animal found on Earth originally existed in what biologists term its range, the region in which it naturally occurs.

Ranges expand or contract in response to a variety of natural events, such as changing weather, availability of food, volcanic eruptions, floods, and droughts. Throughout the course of history, however, the ranges of many organisms have been greatly altered in response to the actions of humans. In some instances, range expansions are viewed as a universal good. In others, such disruptions of the natural order have caused, and continue to cause, serious problems for humans.

Insects that now occur in regions where they originally were not present have in many cases become what we call "pests." North American examples include the European corn borer, Hessian fly, gypsy moth, and a host of others.

The gypsy moth is one of the most infamous invaders. Native to Europe and Asia, it was introduced into North America in 1869 by Leopold Trouvelet, a French scientist attempting to develop a silk industry who wished to cross the gypsy moth with the silk moth to produce a new and improved silk-producing caterpillar. Although the endeavor failed, he did succeed in "losing" a few gypsy moth caterpillars that he was growing on a tree near his house in Massachusetts.

The rest is history.

The gypsy moth soon became established and continues to be the most destructive forest pest in the eastern United States. Even though hundreds of millions of dollars have been spent on its control, the insect continues its inexorable march across the country. The tendency of female moths to lay their eggs on low-lying objects, including such items as lawn chairs, firewood, and car and camper bumpers, provides an easy means of relocation for this aptly named pest.

In 1973, infestations of gypsy moth were detected in Illinois. Since then, the state has continually eradicated the moth at numerous sites around the state, primarily in the northeastern counties, and is currently "holding the line."

Another immigrant pest, the Japanese beetle, was accidentally introduced into New Jersey on nursery stock, made its way into Illinois, and was the object of costly trapping and eradication programs during the 1950s. In spite of these programs, the beetle persists in Illinois and over the last several years appears to be increasing in abundance. Similarly, the cereal leaf beetle, a European pest of small grain, was the object of quarantine and eradication efforts after it was discovered in 1965. Repeated aerial sprays of malathion to hundreds of thousands of acres on which beetles had been detected failed to prevent its statewide establishment in a mere seven years!

The invasion continues.

Since 1960, at least fifty-four new insect species have appeared in Illinois. Seven species have become pests, eleven have only limited potential for economic or health consequences, and eight are actually beneficial (often purposely introduced as part of a pest management scheme). The remaining twenty-eight species are of unknown significance but may turn out to be of little consequence.

It appears that we must learn to live with, and learn to manage, many of our immigrant insect pests. — *Michael Jeffords, entomologist and public relations and education liaison, and Charles Helm, research scientist, Illinois Natural History Survey*

Aptly named, deer ticks can wreak havoc on deer populations; they also are known to transmit Lyme disease to humans.

Deer ticks are also known as black-legged ticks. Below, left to right: male, female, and engorged female.

Courtesy Agricultural Research Service-USDA

Courtesy J.M. Pound, Agricultural Research Service-USDA

especially well represented. In general, the collections serve as a database of actual specimens that documents the changing state of the biota through time.

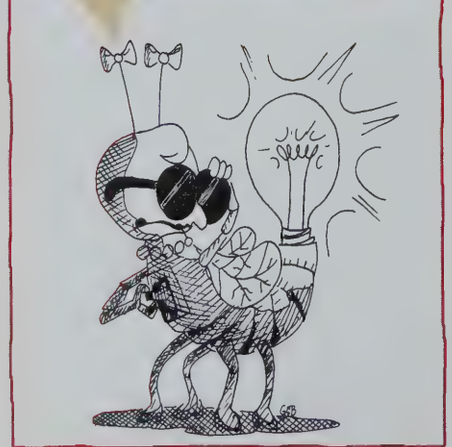
Collection Includes Large Insect Component

The insect collection is particularly strong, containing some six million specimens. The collection contains the largest holdings of midwestern insects to be found. It also incorporates materials from throughout North America and from other continents.

One of the important uses of the material in the insect collection is to serve as standards of reference for the identification of specimens submitted to Survey taxonomists for determination. Because all information known about an organism is stored under the scientific name of the organism and the retrieval of such information is possible only through knowledge of the name, the importance of accurate identification is evident. Equally important is the continual updating of names of specimens, which is a group effort involving not only the residents specialists but also researchers worldwide who use the collection.

The Natural History Survey's resident specialists receive thousands of specimens each year. These submissions come from a diverse clientele that includes agronomists, horticulturists, farmers, gardeners, extension personnel, conservation professionals, wildlife biologists, grocers, warehousers, elevator operators, pest-control operators, physicians, veterinarians, homemakers, and law enforcement officers.

Light production by fireflies is far more efficient than by electric light bulbs. In firefly lanterns, almost 100 percent of the energy produced by the chemical reaction is released as light, whereas in an electric light bulb about 90 percent of the energy is lost in the form of heat.



Collections Serve Practical Purpose

Often the identification services of the Natural History Survey provide the first notice that an insect new to the state has arrived and possibly become established. Examples of such are numerous. Recent immigrants identified by the lab include the imported crucifer weevil, which threatened to devastate the important Illinois horseradish industry, and the deer tick, the vector of the causative agent of Lyme disease.

Provision of in-house identification services also supports studies in pest management and crop protection, ecological studies, conservation studies, and even medical and veterinary investigations. The tie to public health is of ever-increasing importance with the recognition of recently described diseases such as Lyme disease, human ehrlichiosis, and granulocytic ehrlichiosis.

In addition to the functions of service and support for other programs, the collections of the Illinois Natural History Survey have been and continue to be of vital importance to the personal research of the systematists, or taxonomists, who provide those services. Since the founding of the collections in the nineteenth century, numerous specialists have based revisionary studies of groups of organisms and formal works treating of the occurrence of animals and plants in the state upon them.

Illinois Flora and Fauna Are Ever-Changing

In summary, the biota of Illinois is rich and diverse — but it is not static. Throughout the history of the state there have been extinctions and immigrations. In addition, there have been purposeful introductions, some of which were successful, others that were not.

Most of the insect pests of current concern to Illinoisans represent introduced elements. Thus, there is continuing need to monitor the insect fauna of the state. Doing so can provide important indicators of environmental health and of new threats to the material resources of the state and to the health of its citizenry.

John Bouseman, associate professional scientist, Illinois Natural History Survey

Entomology's Past, Present, and Future

May Berenbaum

When you visit the University of Illinois, you won't find all of the entomologists in the same office. In fact, you won't even find them in the same building.

Locating an entomologist on campus can be a daunting task because people who describe themselves as entomologists are housed in six different departments, in four different colleges, and in two different state institutions. These authorities on arthropods are found in the College of Liberal Arts and Sciences, in the College of Agriculture, in the College of Veterinary Medicine, at the Illinois Natural History Survey, and even in the College of Fine and Applied Arts.

Why are our entomologists so widely dispersed? The answer lies both in the history of entomology as an academic discipline and in the unique qualities of this area of science.

DAVID RECES

May Berenbaum, top, examines a Luna moth.
The professor explains insect behavior to students in one of her lab classes.

It wasn't until the sixth century that Westerners were able to break the Easterners' secret to silk production. The emperor Justinian sent two Nestorian monks to China to smuggle out some eggs of the silkworm caterpillar. The monks managed it by concealing the eggs inside the bamboo staffs that they as pilgrims were expected to carry around them. The ruse was successful, and as a result all of the silkworms in Europe and the United States were descendants of these eggs.

Metamorphosis of Entomology

Entomology began as an independent discipline at the UI and other public universities in a very different era. There was a time, not so long ago, when the study of insects was regarded at best as a harmless diversion and at worst as an indication of serious mental imbalance. Even after the publication of the decidedly scientific undertakings of Carolus Linnaeus and other early taxonomists, insect illustrations were benevolently regarded as "prints that would amuse children and keep them out of mischief" (Kirby and Spence 1822) or as challenging models upon which ladies might try out their artistic expertise.

In the early nineteenth century, entomology was thought to be the proper pastime for the idle, the effete, or foppish — for those who could find no better way to spend their time. This reputation was hardly merited by the realities of working with insects. Systematists, who classify insects, and collectors had to endure tremendous hardships and to face considerable physical danger to pursue their interests in the more remote parts of the planet, and physiologists who worked with insects faced operational challenges far greater than those posed by working with much more conveniently sized vertebrates. A human liver, for example, can be weighed in pounds; the midgut of a caterpillar, which functions as a liver, weighs on the order of one thousandth of an ounce. Dissecting tiny organs requires steady hands and tremendous patience.

By the mid–nineteenth century, however, the public no longer had the luxury of indulging in this misperception of the discipline. Insects, by virtue of their numbers and voracity, began to put pressure on the U.S. government for increased recognition. The outbreak of the Rocky Mountain locust plague between 1874 and 1876, so enormous that observers reported seeing trains stopped by the crushed bodies of locusts covering the tracks, led to the appropriation by Congress of $18,000 in 1876 for the establishment of the U.S. Entomological Commission. Appointed as chief was one-time Illinois resident Charles Valentine Riley, whose lobbying had pushed the bill through.

Soon afterward, Riley assumed the position of USDA Entomologist and contributed considerably to the advance of so-called economic entomology by engineering the first successful application of biological control — introducing the Australian ladybird beetle to California to combat the cottony-cushion scale. He also pioneered the use of chemical insecticides in U.S. agriculture and expanded the chemical arsenal then in use to include fumigants, arsenicals, and other inorganic insecticides. Upon his appointment to the position of Curator of Insects at the U.S. National Museum in 1885, he donated his entire collection to the institution, thus forming the base for one of the world's largest and most comprehensive insect collections.

Yet another accomplishment in which Riley took part was the founding of the Association of Economic Entomologists. Established at an American Association for the Advancement of Science meeting in Toronto in early 1889, the association had its first meeting with the Association of Agricultural Colleges and Experimental Stations right here at Urbana, Illinois, that November. The society began publishing the *Journal of Economic Entomology* in 1908 and the following year changed its name to the American Association of Economic Entomologists.

That there were sufficient numbers of entomologists in 1889 to form a society is itself a little surprising. That there were enough entomologists of sufficiently different interests to start another national organization, the Entomological Society of America, in 1906 is even more surprising. And in view of the hitherto unflattering opinions of the public toward entomologists, it almost defies belief that several acts of Congress actually created this abundance of entomologists.

Yet Congress really had little choice in the matter. What with the encroachment of the gypsy moth, the San Jose scale, and the cotton boll weevil in the latter half of the nineteenth century, it was as if the forces of nature were lobbying in Washington on behalf of the entomologists. The Morrill Land Grant Act, passed in 1862, led to the establishment of the land-grant universities, where instruction in entomology was quickly established. The Hatch Act of 1887 created a nationwide system of state agricultural experiment stations, in part to support entomological research.

Insects Continue to Demand Our Attention

A century later, it is no less true that insects constitute the most economically important class of animals on the planet. Despite the outstanding successes of economic entomologists over the past century, insects continue to damage crops, spread disease, destroy property, and otherwise wreak havoc. For every insect that is tamed or eradicated, a few new pests are accidentally introduced into the country. The past few years have seen our borders invaded by Asian tiger mosquitoes, Asian gypsy moths, European pine shoot borers, Russian wheat aphids, and Africanized honey bees — all posing a serious threat to health and prosperity.

Even the most subtle alteration in an ecosystem can provide an opportunity for an inoffensive species suddenly to turn virulent, and in the latter half of the twentieth century, alterations to ecosystems have been anything but subtle. These hitherto inconspicuous arthropods-turned-troublemakers include the deer tick, principal vector of Lyme disease, which has expanded its range astronomically in a remarkably short period, and northern corn rootworm, which can no longer be controlled simply by rotating corn and soybeans. Some experts estimate that total insect damage in the United States exceeds $14 billion annually and continues to climb with no abatement in sight.

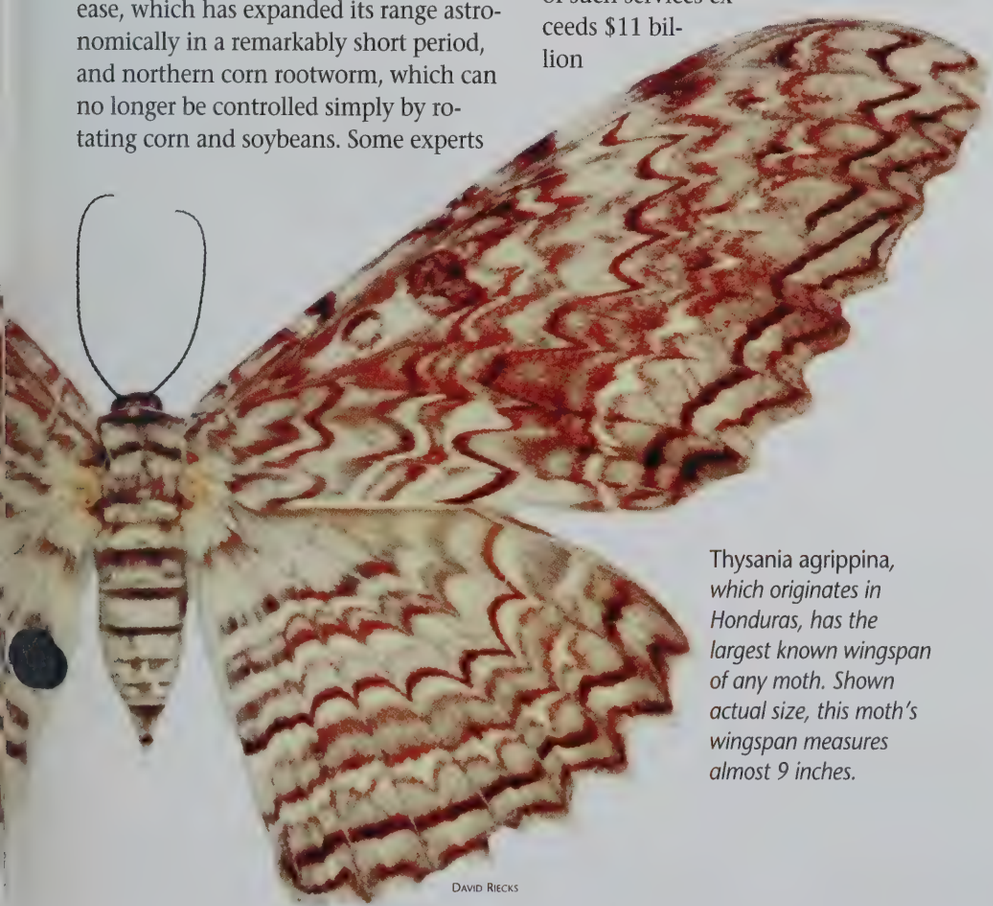
On the other side of the coin, even in today's technological society, insects contribute economically at a level unequalled by any other class of organism. The value of insect products — honey, wax, silk, and the like — alone amounts to more than $330 million annually. Rather than being replaced by synthetic substitutes, insect products such as silk and cochineal (a red dye) are experiencing a renewed popularity. Spider silk, for example, is under intense scrutiny by material scientists who have yet to develop a synthetic fiber with its strength and elasticity and by molecular biologists who want to clone the genes that produce silk protein into bacteria for mass production.

The positive economic benefits don't end with insect products. The value of insect products is greatly exceeded by the value of insect services such as pollination, recycling of organic wastes, and biological control. Collectively, the worth of such services exceeds $11 billion annually in the United States alone, and controlled, reliable delivery of those services depends critically on entomologists who are familiar with the systematics, population biology, and ecology of the insects that provide them.

Recently insects have gained in importance in another way. Largely through the efforts of university entomologists, insects have become increasingly more valuable to the entire scientific enterprise of the nation, if not the world. The value of insects as model systems for biological research of all descriptions was recognized centuries ago by such polymaths as Marcello Malpighi and Jan Swammerdam, but the scientific community as a whole was a little slower to catch on. A fundamental discovery in the 1920s forever altered the science of biology — Thomas Hunt Morgan discovered just how convenient it was to use *Drosophila melanogaster*, the famed "fruit fly" (referred to more precisely by entomologists as the vinegar or pomace fly) for his studies of genetics. As a result of that discovery, fruit flies in particular, and insects in general, are effectively irreplaceable as study organisms in biological subdisciplines as widely divergent as genetics, molecular biology, neurobiology, and evolutionary biology.

Understanding the limits of insects as model systems, however, and elucidating those aspects of biology that are unique to the class Insecta are still the job of the classically trained entomologist, who can study the life of the organism for its own sake and who can integrate all aspects of its biology in a holistic way. The importance of insects in this role is only going to increase in coming years, as working with vertebrates becomes economically and ethically more difficult to justify.

An increasing emphasis on the inventorying and conservation of biodiversity, evidenced by such recent developments as the creation of the National Biological Survey, will necessarily make the study of insects a higher priority for our nation and the world — after all, insects constitute at least 75 percent of all living organisms. Although more than 800,000 species of insects are known, estimates of the number of arthropods remaining to be discovered and described range from



David Riecks

Thysania agrippina, *which originates in Honduras, has the largest known wingspan of any moth. Shown actual size, this moth's wingspan measures almost 9 inches.*

This small collection shows some of the great variety found among the world's insects.

10 million to 34 million. These species, an untapped source of potentially useful goods and services, can only be recognized by people who have been trained as entomologists. And people can only be properly trained as entomologists in an academic setting, where collections are maintained, where colleagues with the appropriate expertise are nearby, where the latest techniques available for insect classification can be mastered, and where the necessary scientific literature is readily accessible.

Entomologists are versatile — too often a rare trait among scientists. For decades, they have found employment not only in the realm of academic basic research but also in government, the military, industry, and foreign service. There are few professions whose practitioners have so routinely found employment in such a broad range of sectors, and there are few whose disciplines require such broad training.

Perhaps one reason for the versatility of entomologists is that entomology, both basic and applied, is by nature multidisciplinary. Agricultural entomologists have long worked with soil scientists, plant pathologists, and even agricultural economists to devise integrated approaches for managing insect pests. Medical and veterinary entomologists have forged partnerships with microbiologists, animal scientists, and epidemiologists to solve some of the world's most pernicious health problems. And basic insect biologists have collaborated with colleagues in every area of life science to achieve a better understanding of the systematics, ecology, physiology, genetics, and cell biology of insects.

As emphasis on multidisciplinary work increases, entomologists should become more, not less, valued. Indeed, this ability to integrate into a wide range of disciplines is why entomologists are housed in so many different units on campus.

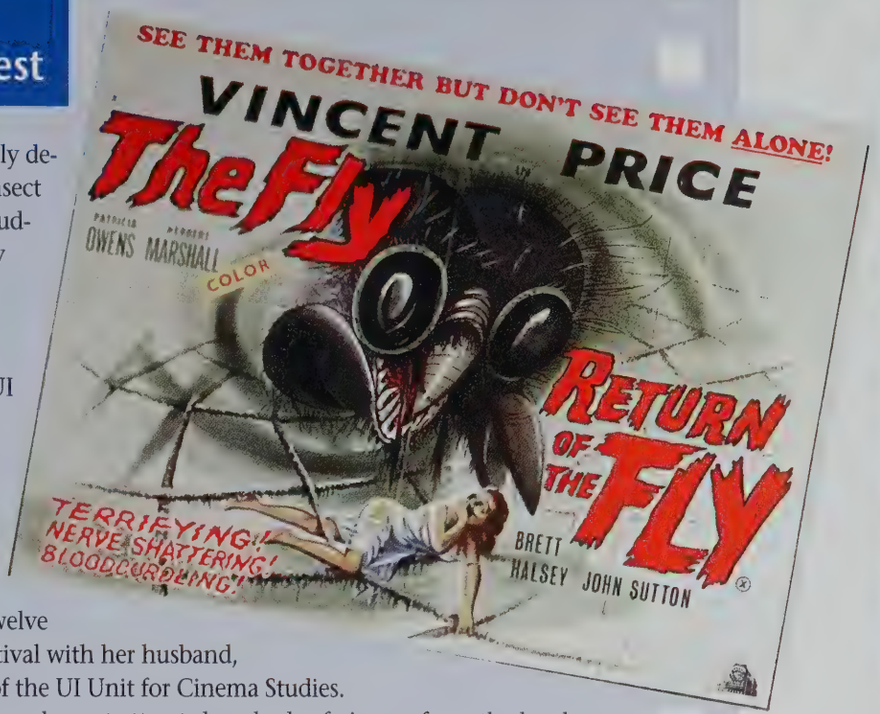
A Bright Future Ahead?

The future of entomology, then, appears to be bright. There is no question that entomology continues to contribute to the national good. Tangible proof of the importance of the field includes the fact that last year, of six scientists awarded the National Medal of Science, the highest honor bestowed upon scientists in this country, one is an entomologist. Last year, among the sixty scientists elected to the National Academy of Sciences, which selects its members from thousands of candidates in dozens of science disciplines, two were entomologists — quite an accomplishment for a field whose national society membership boasts fewer than ten thousand members.

As long as insects are intimately involved in the daily activities of humans, which has been the case since the dawn of time, the study of entomology will continue to occupy a unique and important position at land-grant universities throughout the nation.

May Berenbaum, head, UI Department of Entomology

Two Thumbs Up for UI Film Fest



As she sat in her office enthusiastically describing the offerings of this year's Insect Fear Film Festival, May Berenbaum suddenly said she had to run. Her family expected her home soon to watch a new video — "Brain Eaters."

"It's one of the greatest secret pleasures that I allow myself," the UI entomology professor says of her fascination with insect films.

Both a love of cinematography and an unending drive to be creative led Berenbaum, head of the UI Department of Entomology, to found the Insect Fear Film Festival twelve years ago. She now co-directs the festival with her husband, Richard Leskosky, assistant director of the UI Unit for Cinema Studies.

The annual event attracts hundreds of viewers from the local community and brings the nation's journalists out of the woodwork. Wearing antennae and wielding fly swatters, spirited festival-goers swarm to the UI each February for some of the best — and the worst — of science-fiction cinematography, including such notables as "Mothra," "Godzilla vs. Mothra," "The Deadly Mantis," "The Fly," "The Return of the Fly," "Empire of the Ants," "The Savage Bees," "Of Thee I Sting," and "Invasion of the Bee Girls."

As might be expected, most of the festival's movies are glaringly inaccurate when it comes to insect biology. But these inaccuracies aren't all bad. They provide Berenbaum with a perfect teaching opportunity and a chance to set the record straight on the Earth's most populous group of organisms.

At the festival, young and old can get an up-close view of their favorite bugs, partake of edible insect munchies, or just sit back and get a quick lesson on the eating habits, mating rituals, and communication methods of members of the class Insecta.

"Actually, the truth about insects is often more amazing than the movie industry's fiction," Berenbaum says. For instance, many filmmakers have tried to impress moviegoers by portraying gargantuan mutants. But shouldn't we be just as impressed by the reality of an insect's incredibly complex system of muscles, nerves, and internal organs all packed into a tiny body?

Berenbaum's all-time favorite flick is the 1957 thriller "Beginning of the End." The film has great appeal for residents of the Prairie State — giant grasshoppers destroy the central Illinois town of Paxton before marching down Chicago's "Magnificent Mile" threatening to take over the city.

Let's face it — we've all jumped at the unexpected sight of a bug scurrying across the kitchen floor. Despite their diminutive size, insects do have the power to strike fear in the hearts of humans. — *Nancy A. Nichols, editor, Office of Agricultural Communications and Education*

The next Insect Fear Film Festival is scheduled for February 1996. For specifics on the event, call the UI Department of Entomology at (217)333-2910.

Movie posters taken from *Graven Images: The Best of Horror, Fantasy, and Science Fiction Film Art*; from the collection of Ronald V. Borst and Margaret A. Borst; edited by Ronald V. Borst, Keith Burns, and Leigh Adams; © 1992 by Borst Book Group.

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Agricultural Experiment Station • D.A. Holt, Director
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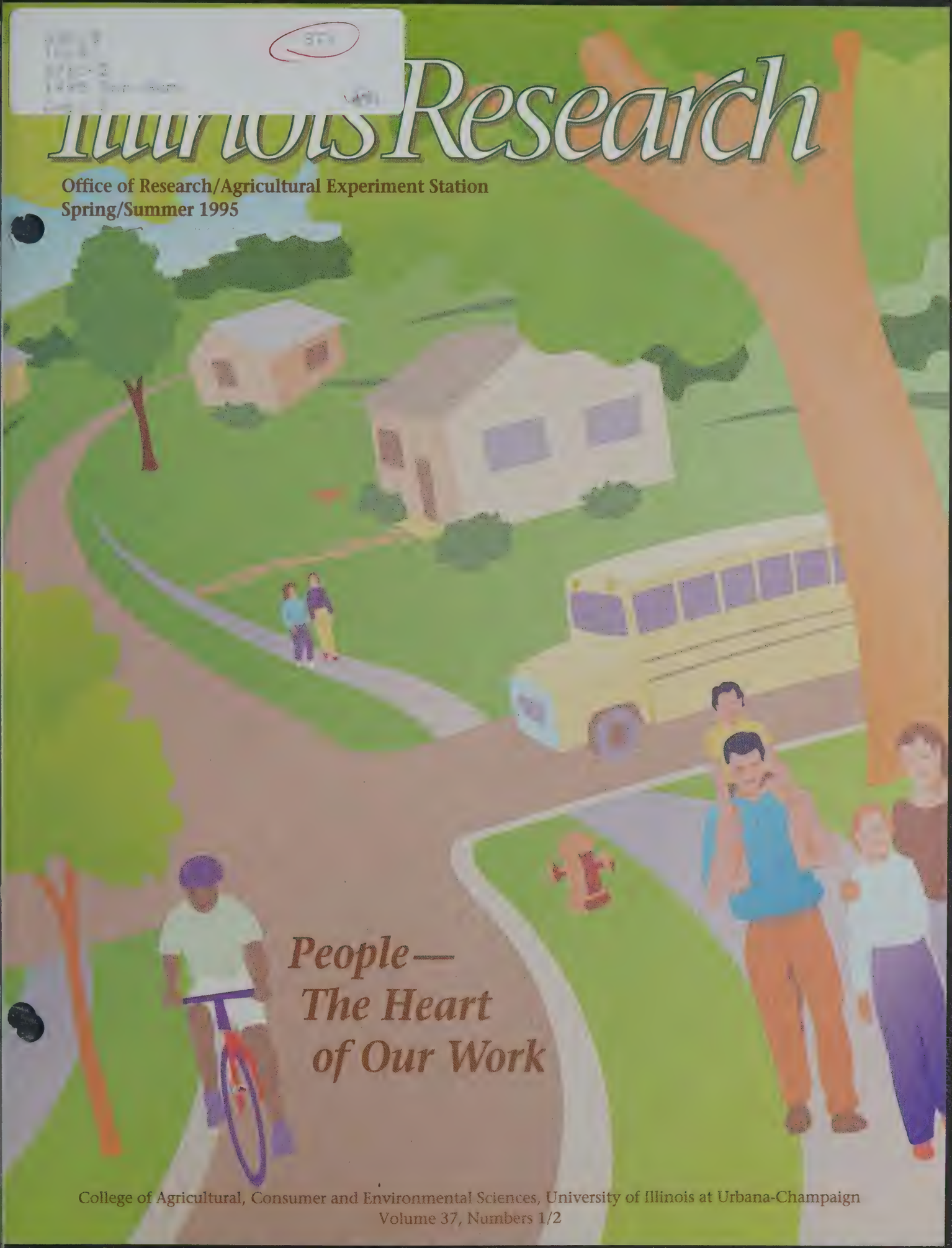
- Tough challenges facing today's youth
- Pressures on families in the nineties
- Society's need for effective interpersonal communications
- Tailor-made community development
- Health, fitness, and wellness
- Designing research to tackle complex sociological problems

Illinois Research

Office of Research/Agricultural Experiment Station
Spring/Summer 1995



People— The Heart of Our Work

College of Agricultural, Consumer and Environmental Sciences, University of Illinois at Urbana-Champaign
Volume 37, Numbers 1/2

The Cover

Some say the strength of our nation depends on the vitality of our families and communities. So what is the College of Agricultural, Consumer and Environmental Sciences doing to help? The stories in this issue provide a sampling of the College's extensive research and outreach programs that provide practical means for improving people's quality of life.

Cover illustration by Loren Kirkwood

Illinois Research
Spring/Summer 1995
Volume 37, Numbers 1/2

Published by the University of Illinois at Urbana-Champaign, College of Agricultural, Consumer and Environmental Sciences, Office of Research/Agricultural Experiment Station

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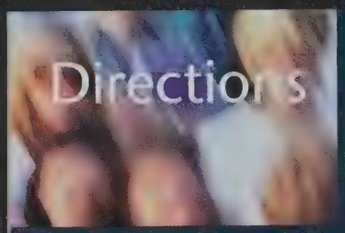
Good Luck, Paula

After twenty-three years of service in the College, including fourteen years as art director of *Illinois Research*, Paula Wheeler is leaving the magazine. She plans to devote more time to Wheeler Arts, the communications company she started with her husband, Steve Wheeler. Paula's artistic touch and many contributions have guided *Illinois Research* through several changes, including a major redesign in 1992. We acknowledge the key role Paula has played in shaping the magazine and wish the Wheelers continued success.

Contents



A New Vision for Human Sciences

As we move toward the twenty-first century, individuals, families, and communities are being challenged by many factors. Families are confronted by a fast-paced, ever-changing, high-technology world. They must balance increasing financial pressures and problems of time management against dual careers and child care needs. Needs to improve individual health must be balanced against rising health care costs and challenges to modify lifestyles to achieve proper nutrition and fitness. How do we address the risk behaviors of youth and changing family dynamics? What are the impacts of public policy on health care, consumer choices, adolescent behavior, and community development?

The articles in this issue focus on these and other important questions in the area of "human sciences," in which the University of Illinois College of Agricultural, Consumer and Environmental Sciences has a long tradition of excellence. Over the years, our faculty's contributions to nutrition, food quality, child development, family studies, textiles, and consumer economics have helped to enhance the quality of life for people in Illinois and around the world.

Increasingly, the success of a land-grant university such as the University of Illinois is dependent on its ability to change. Throughout the University's existence, continuous improvements in agricultural production and efficiency decreased the need for large human capital for production of food and fiber. In the 1800s, more than 75 percent of U.S. workers were employed on farms. Less than 5 percent of the nation's workforce is employed on farms today.

When the majority of Americans lived and worked on farms, the College's research and extension programs focused on improving the productivity of the agricultural system and enhancing the well-being of rural families. Today's families, living in both rural and urban areas, have different needs but maintain equally profound connections to agriculture and the land-grant university. It is individuals and families who consume products, influence production through their market decisions, use land and environmental resources, provide labor, support education, and teach values—values that guide society's use of natural resources, define product quality, and shape development of human capital. The opinions of these individuals and families have an ever-increasing impact on the directions of our programs in the human sciences.

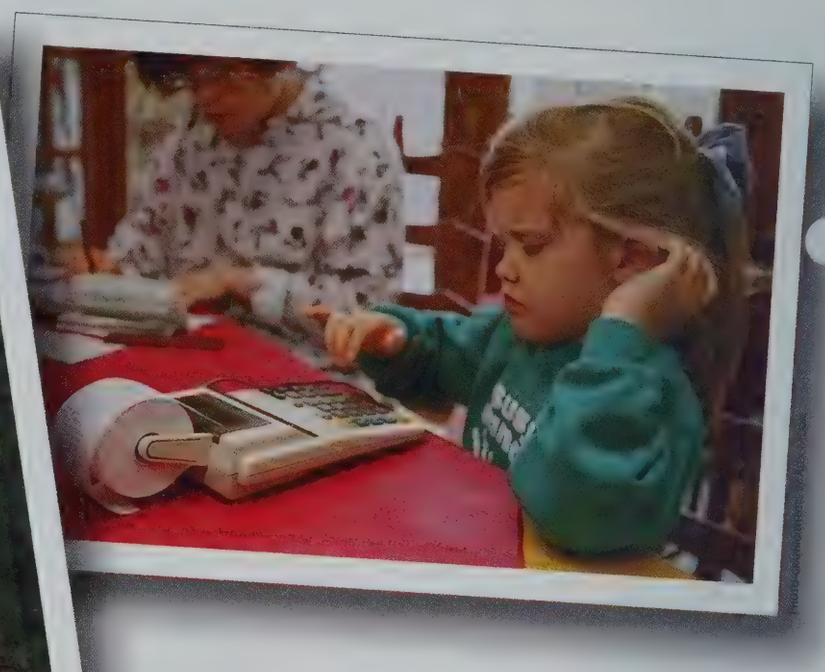
Clearly, as an educational institution the UI College of Agricultural, Consumer and Environmental Sciences is being challenged, just as individuals, families, and communities are being challenged. And our College's response to the challenge is evident. Our research and outreach missions are being refined to focus more fully on critical needs of today's society—which include the well-being of individuals and families, the economic and environmental stability of our communities, and the global competitiveness and leadership of our nation. And we are designing this research and outreach to produce practical results—results that enhance the quality of life of people in Illinois, the United States, and the world.

Sara Douglas, associate professor of textile marketing and economics; Donald Layman, professor of nutrition; and Joseph Pleck, associate professor of human development


MEET THE GREGE

When society bid farewell to the '50s lifestyle and Mom entered the work force, families embraced a whole new set of challenges. Time became a scarce resource, children entered daycare en masse, and housework took a beating on the priority list. With the traditional roles abandoned, working couples began to reconsider decisions on the division of labor in their households. Who would pick up the children from daycare, pay the bills, and take out the trash? In the spirit of pioneers, today's working couples are finding new ways to keep the family fully functioning through sacrifice, give-and-take, and compromise. Take, for instance, the Gregersons from Gibson City, a small town in central Illinois...

Lisa Sheppard
Photography by Brian Stauffer



Like so many couples, Dave and Lisa Gregerson find it challenging to work full time while raising a family.

The alarm clock in Dave and Lisa Gregerson's bedroom rings at 5:45 a.m., and so the routine begins again. Another day to arrange schedules, manage household chores and child care, log in a full day's work, and find quality time for the family.

Like so many couples, the Gregersons find it challenging to work full time while raising a family. But because of varied work schedules, Dave and Lisa must take extra care to finagle a reasonable division of responsibilities.

Lisa, who is expecting a second child soon, is employed as assistant cashier at the Bank of Gibson City from 8 a.m. to 4 p.m. Monday through Friday, plus 8 a.m. to noon every other Saturday. She has one afternoon off every other week to make up for the Saturday hours.

Dave, an extruder operator at Central Soya, Inc., in Gibson City, describes his seven-day swing work schedule this way: "I work 7 a.m. to 3 p.m. for six days, then have two days off. I then work the second shift, 3 to 11 p.m., for seven days straight, then have two days off. Then the third shift is 11 p.m. to 7 a.m. for seven days, then I have four days off." Dave occasionally works up to eight hours of overtime per shift.

Both Lisa and Dave share the duty of taking daughter Victoria, 5, to the babysitter at 8 a.m., taking her to preschool three days a week, and picking her up at 4 p.m. When Dave works the second or third shift, he walks with Victoria to nearby Busy Hands Nursery School on preschool mornings, returns home to sleep for a few hours, then picks her up from preschool and takes her to the sitter's home. A few times a month, Lisa arranges with another parent to pick Victoria up from preschool.

On days when Dave finishes work at 3 p.m., he picks up Victoria from the sitter and takes her home. On other afternoons, Lisa drops by the sitter's on her way home from work.

"It's a day-by-day schedule," Dave said. "Actually, it works out really well, as goofy as it is. It's impossible to try to explain to somebody. It just doesn't make any sense until you do it."

Once the family became acclimated to his revolving work schedule, they found it suited their needs.

"I think the schedule really helps," Lisa said. "If Dave worked 7 to 3 every day, I would have to arrange to take

Victoria to the sitter at 8, turn around and leave work at 8:30 to take her to preschool, then leave work to pick her up at 11, then go to lunch from 12 to 1. This way, Dave is able to spend more time with her when I'm at work."

The Gregersons' erratic schedule is not that uncommon, according to Holly Hunts, consumer economics specialist for the University of Illinois Cooperative Extension Service. Hunts studied data of 999 households nationally with dual-income parents and children under age 5, taken from the 1990 Urban Institute National Childcare Survey. She found that 26 percent of respondents work a schedule that varies from week to week, and 20 percent work on weekends.

Men were more likely to work nontraditional hours and, thus, mothers had more time to care for children than did fathers, according to research.

"There is the notion that women are in the service jobs working crazy hours, but that is not what the data say," said Hunts.

After the Baby

Women who drop out of the work force to raise the kids have much to sacrifice, Hunts said. They lose pay, pension benefits, affordable health care, job security, and career advancement. If a woman decides to return to work when the children are older, she must compete with younger employees who have up-to-date work skills.

Studies have shown that employment boosts self-esteem and may actually protect women from depression and anxiety. The more roles a woman plays—life partner, mother, employee—the more chance for a challenging, rewarding life.

To balance family and career, many women choose jobs with enough flexibility to accommodate family needs, often at the expense of higher wages. Still others have fewer children later in life and can afford to pay for child-care arrangements to pursue their own careers. Most women have a dual alliance to family and work, attempting to be good mothers and good workers.

Once Lisa and Victoria became acclimated to Dave's "goofy" work schedule, they found it suited their needs.

Three months after Lisa Gregerson has her baby, she plans to return to her position at the bank where she has worked for the past ten years. She works not only for economic reasons but also for the personal rewards.

"At the end of my eight-week maternity leave when Victoria was born, I was ready to go back to work," Lisa said. "I was missing the women at work, and I missed being out with the public. Honestly, I was ready to get back into a routine."

Lisa said she regrets missing school parties or other important events that happen during the day in Victoria's life, but she wouldn't choose to stay at home full time. However, she would switch to part-time employment if that were an option in her position.

Money Matters

Their combined income allowed the Gregersons to purchase their first home and take on household projects, such as wallpapering the living room and purchasing part of an adjacent lot to add on to their property. Previously, while the couple rented a home from an uncle, Dave paid the bills.

But after buying the house, Lisa took hold of the purse strings.

"He was too lenient in paying the bills," said Lisa, "and I knew that if we bought the house we would be pinching pennies. We had to keep a tight checkbook. So I took it over."

The two contribute equally to the decisions about major purchases, such as appliances, and both shop around before making a decision.

The Gregersons' money management decisions are similar to findings of UI studies on which spouse pays the bills and looks after getting cash, and who makes important financial decisions for the family.

Vicki Fitzsimmons, Extension family economics specialist, studied survey results of married couples taken from 1968 to 1981. In comparing money management habits when the couples first married to 13 years later, she found that responsibility is likely to change as couples move through the life cycle.

The most significant finding is that couples may start off the marriage managing the checkbook jointly, but the wives usually take over that responsibility.

"Paying the bills is viewed as a clerical function, which is consistent with the homemaker role," Fitzsimmons said. "So it is more common for the wives to take on that responsibility."

In general, however, couples share jointly in money management matters over time, which is consistent with advice that both spouses have input into family finances.

Previous studies have shown that husbands were more likely to dominate the money management role in couples that later divorced. In other words, wives in happily married couples were more likely to have input into money decisions than were wives in couples who eventually divorced.

Although women are becoming more involved in financial decisions on major purchases, men are still dominating the decisions on investments, Fitzsimmons said. Even in relationships in which the wife makes more money than the husband, the men are still making these decisions.

Your Chores, My Chores

The matter of who takes out the trash, washes the dishes, and mows the lawn has traditionally been a bone of contention for dual-earner couples. Men in these marriages do not assist any more with household chores than do men in single-earner marriages, studies show.

Instead, families are lowering their standards for housekeeping, according to Maureen Perry-Jenkins, UI assistant professor of family studies. Families eat out more frequently and spend significantly less time on housework than in years past.

Still, couples fight over the jobs that need to be done, causing marital distress. Women who view the division of labor as fair report a higher level of marital satisfaction in research studies. But fairness is clearly not based on the actual division of labor.

"When we looked at the division of labor in households, we found that although the wives took more responsibility for the housework, many viewed the situation as fair," said Perry-Jenkins. "Women frequently rationalize the unequal division of labor in order to keep the peace at home."

Most couples are still struggling to negotiate a reasonable and satisfactory division of labor for both working spouses, she said.

The Gregersons say they have it all figured out. They split up the chores evenly. Each takes turns giving Victoria a bath, and they split up the laundry duties. She fixes supper; he cleans up afterward. He mows the lawn; she cares for the flowers. Dave fixes his own brown-bag lunches or suppers for work.

"We divide the chores close to 50/50," Lisa said. "Although many of my chores are everyday duties, he takes care of the larger responsibilities—the major household projects. So we're both satisfied with how chores are divided between us."

"Whenever I ask him to do something or I make a list of chores, he's always willing to help," she added.

Time for Family

On the weekends, the family regroups: they visit with relatives and friends, go to church, and spend time at home caring for the house. Each has the freedom to follow up on interests: for Lisa, crafts and shopping for antiques; for Dave, hunting and fishing. Victoria calls Saturday and Sunday "family days" and looks forward to shopping, eating out, or just staying home to bake cookies with Lisa. Dave and Lisa said they rarely have baby-sitters on evenings and weekends, opting instead to bring Victoria along.

"We can take her anywhere that we would go," said Dave. "We usually center our activities around her," added Lisa. "She's our priority right now."

On Sunday nights, the family gears up for another work week. Lisa lays out Victoria's clothes for preschool and daycare. Bath is done by 8 p.m. Then Victoria is put to bed at 9:30.

"Our lives are run on a schedule that we've worked out," Lisa said. "By the end of the night, we're thinking, 'Well, ready for another day of work.' "

Lisa Sheppard, Extension communications specialist, Information Services

A New Member of the Family

There is an addition to the Gregerson family since this article was written. Chandler David was born on May 5, 1995. With the birth of a new child come new responsibilities but also new joys for the family. During her twelve-week maternity leave, Lisa was able to spend time with both children, encouraging Victoria to stay involved in the everyday tasks of caring for Chandler. Lisa keeps a strict bath and bedtime schedule to ensure that the children get a full night's rest and that the household chores are done by the end of the day. As Lisa says, "With the bottles to be washed and laundry to be done, there's not much time to sit back and cross-stitch."

INVESTING IN YOUTH

Tina M. Prow

DAVID RIECKS

Children and teens in Kankakee County find rewarding challenges and opportunities in the local Youth Under Construction program.

In homes across the country, parents carry out the same mental debate every time their children walk through the door: "I should ask what's going on in their lives. No, they'll think I'm snooping. But if I don't ask, they might think I don't care...."

Ask, advises Joseph Pleck, a University of Illinois researcher in human development. Adolescents surveyed at junior high schools in Brooklyn, New York, responded that they wished their parents knew more, not less, about what they were doing. Other research suggests family interaction is important to children of all ages.

Pleck is among a group of UI researchers who are looking at factors that affect child and adolescent development. His ongoing research uses data from a national survey of adolescent males and other studies to identify factors that can be used as predictors of early sexual activity, drug and alcohol use, and other problems.

The data indicate that strict parental rules and high frequency of church attendance have "buffering, protective effects" that help children cope. The research strongly suggests children need interaction with adults and structure in their lives, he says.

It Takes a Whole Village to Raise a Child

Family and church provide stability for many children, but "intervention programs"—designed to keep kids on track or to get kids headed for failure back on track—also are an important way for a community to respond to its children's needs, he says.

"There's no question that life is challenging for many children and for many young adults," Pleck says. "Family and community are prime factors. The family structure of a single parent or teen parents is often tied to ineffective parenting behavior and poverty.

"When parents and community don't set appropriate rules and don't monitor kids' behavior, then a higher percentage of teens engage in high-risk behaviors, such as sex or substance use. Or they may drop out of school—or all of the above and more."

A negative environment does not doom a child to failure, Pleck is quick to add. In fact, some kids show remarkable "resiliency," or an ability to rise above or resist situations that cause other children to self-destruct. Pleck is among those who think resiliency can be enhanced through intervention programs.

Several intervention programs exist to aid troubled adolescents, and though important, the interaction could start sooner, Pleck suggests. His research points to a need for intervention programs designed to engage younger kids, as young as 10 years old, before they are in trouble.

"Kids establish a developmental 'trajectory': some get off the developmental track early, some get back on, and lots never do. The biggest predictor of failure is early failure," Pleck says. "Clearly, kids need more decision-making skills earlier. They have to become better at assessing risks and assessing long-term consequences of behavior. They have to have a perception that they have something to lose through certain kinds of behaviors.

"But it's so much more than 'just say no'—kids need to know how to say no."

At the University of Illinois, a broad program of research explores this and other factors—such as socioeconomic issues, peer interaction, and family structure—that affect childhood and adolescent development. The research is important because misconceptions and stereotypes exist about youth, Pleck says. "Race, gender, poverty, family structure, community—I think the more we find out, the more complex we'll find the picture to be."

Beyond Corn, Cows, and Cooking

One way research can be quickly put into action is through 4-H, a national network of youth education clubs developed nearly seventy years ago by the Cooperative Extension Service, an outreach arm of land-grant institutions such as the UI College of Agricultural, Consumer and Environmental Sciences. CES focuses on the practical application of university research.

At the State 4-H Office on the UI campus, Jeff Miller observes that youth development happens with or without 4-H. But 4-H gives children and adolescents "a chance to try and to fail or succeed without suffering.

"4-H, scouts, church youth groups—these are all organizations that provide positive experiences for children and teenagers," Miller, an Extension youth development specialist, says. "We try to provide a structure where youth are involved with adults, with their parents, and with younger or older peers to develop skills that will be important later in life."

Anyone who thinks 4-H is corn, cows, and cooking needs to take another look, he suggests. 4-H professionals draw on researchers and scholars to build programs that teach 4-H'ers about the world around them and about themselves and that "enable them to become self-directing, productive, and contributing members of society," Miller says.

Projects and demonstrations today are as likely to focus on computers as on corn, and 4-H clubs are as likely to be found in the inner city of Chicago as in rural Illinois. However, the underlying goals the organization has for its members are still the same: to foster an interest in education, a pride in themselves, and a recognition that they can set and achieve their own goals.

"A lot of kids grow up with few problems and it's hard to say how much better off they are because of 4-H," Miller says. "But we believe that those kids as well as others who are developing under adverse circumstances are better able to

Gary Lim

IT'S NO SECRET: KIDS NEED BETTER COMMUNICATION SKILLS

Classroom teachers and other people who work with children from grades 3 to 8 will soon have a new resource for teaching communication skills. A far cry from the tedium of memorizing spelling words and diagramming sentences, the lively new educational materials address basic communication skills from an interpersonal perspective.

Working with the state 4-H office, communication specialists in the College of Agricultural, Consumer and Environmental Sciences have focused the materials on nonverbal communication, listening, talking, reading, and writing. The first set of student workbooks to be completed offers activities ranging from expressive arts to field observations of how people use wordless cues in their daily lives.

Teachers who evaluated and helped refine the workbooks pointed out numerous uses for the lessons—from developing conflict resolution skills, to building a sense of body awareness in oral presentations, to providing an avenue for student–parent interaction.

The workbooks are written for third-, fifth-, and seventh-grade reading levels. Call (217) 333-2007 for ordering information.

Mary Overmier, publications editor and coordinator for the 4-H Communications Curriculum Project, Information Services

compete in the world because of their experiences in 4-H."

The world and society have changed greatly since the first 4-H club formed early in this century, and so has 4-H, in part because the strong link to research and scholarship allows the program to be responsive to changing needs of youth. One reason for the success of 4-H over the years, according to Miller, is that 4-H has always recognized the importance of family and community—key influence factors identified in Pleck's recent research.

Miller considers the relationships 4-H fosters between young people and adults fundamental to promoting resilience in youth. Adults—whether 4-H professionals, volunteers, or parents—provide guidance and supervision on all 4-H projects and activities.

This blending of people from different walks of life makes 4-H an innovative and creative organization, says Sheri Seibold, a youth development educator at the Kankakee Extension Center. She considers the 4-H emphasis on training adult volunteers to understand and interact with different ages and stages of youth development key to the successful relationships she sees.

"Volunteers are taking on a larger leadership role in 4-H, and the training program helps make them very effective," Siebold says. "We know kids need interaction with adults; 4-H provides the impetus to bring kids and adults together in a quality way."

The organization's professionals work with volunteers and parents to ensure they understand how to interact, encourage, and motivate members. 4-H also offers programs that help parents hone parenting skills, such as helping their children with homework.

Although 4-H has a strong focus on helping individuals find and develop strengths in themselves, the program is broad enough to affect communities. Some clubs clean parks, help the elderly, and volunteer in their communities.

"Community service is a way to help kids understand that they have something valuable to contribute, that they are an important part of their community, and that they have a stake in what happens there," Miller says.

"Eventually," he says, "we all need to know that."

Tina M. Prow, science writer, Agricultural Experiment Station

DAVID REED

Through 4-H, kids get varied opportunities to interact with adults, who provide the youngsters with positive role models and just simple friendship.

4-H YOUTH IN ACTION

Kids develop the life skills they need to be happy, healthy adults.

The 4-H system in Illinois is an example of an "intervention program" to help youth deal effectively with everyday challenges—and to help prepare them for the future. Standing for "head, heart, hands, and health," 4-H is designed to be fun *and* educational.

Every project and program helps 4-H'ers, and often parents, develop and hone the skills they need for life: leadership, decision making, communication, and a greater understanding of self and others.

These are just a few examples of the 4-H programs carried out in Illinois:

High school students take over the General Assembly chambers in the state capitol in Springfield each year—not in protest, but to get a firsthand feel for the legislative process. About two hundred students attend the annual **4-H Legislative Forum.** The students participate in debating a mock bill. The experience of presenting the pros and cons of an issue helps to improve leadership skills. And being on the same floors where legislators work helps young people understand that they can have a positive influence on their communities by getting involved in the political process.

Young people get a taste of career possibilities during **4-H Space Camp,** sponsored by 4-H programs from several states in cooperation with the U.S. Space and Rocket Center in Huntsville, Alabama. Each year about 350 4-H'ers from Illinois attend the camp.

Helping young people realize their potential to be productive individuals, team leaders, and community members is a full-time job for 4-H educators. One of the most effective programs is **Language of Colors,** which helps participants learn to recognize key characteristics of behavior and personalities. "Everyone encounters individuals that they just don't understand. Yet when they can identify certain characteristics, they are better able to interact," says Bill Million, a CES youth development educator in central Illinois.

A national 4-H curriculum, **Talking with TJ** helps both kids and adults recognize and deal effectively with conflict. The program gets participants to recognize expectations of others and to articulate their own. "Conflict is a normal part of everyday life," says Marilyn Norman, a CES unit leader in the Chicago area. "So it's important for kids to understand the language of conflict and to manage their anger. They need to be able to state their perspective and yet learn to respect other points of view."

BRIAN STAUFFER

Walk in My Shoes helps young people empathize with their elders.

Developing a sensitivity to others is the focus of **Walk in My Shoes,** a program that makes young people aware of the challenges older people face. It won Extension's Outstanding Program Award last year and drew international attention. Molly McErlean, a family-life educator in the south Chicago area who developed the program, says that kids who participate in the program develop an understanding of the stereotypes and mistaken notions they have about older adults.

4-H also looks to club members for leadership through a special program for junior high and high school members called the **4-H Ambassador Program.** The program equips them with the skills to represent 4-H to schools, community groups, city councils, state representatives, and others. The program is a chance for younger kids to see older ones as role models and for the community to see adolescents in positive roles.

Role models and positive examples are the focus of a before- and after-school program for kindergarteners through fifth-graders called **Lincoln Learning Trails.** The program offers social skills coaching that includes modeling of appropriate behavior. Success of the program is evident in improved academic performance of participants.

For more information on 4-H programs in Illinois, call 1-800-394-5982.

Healthy Choices

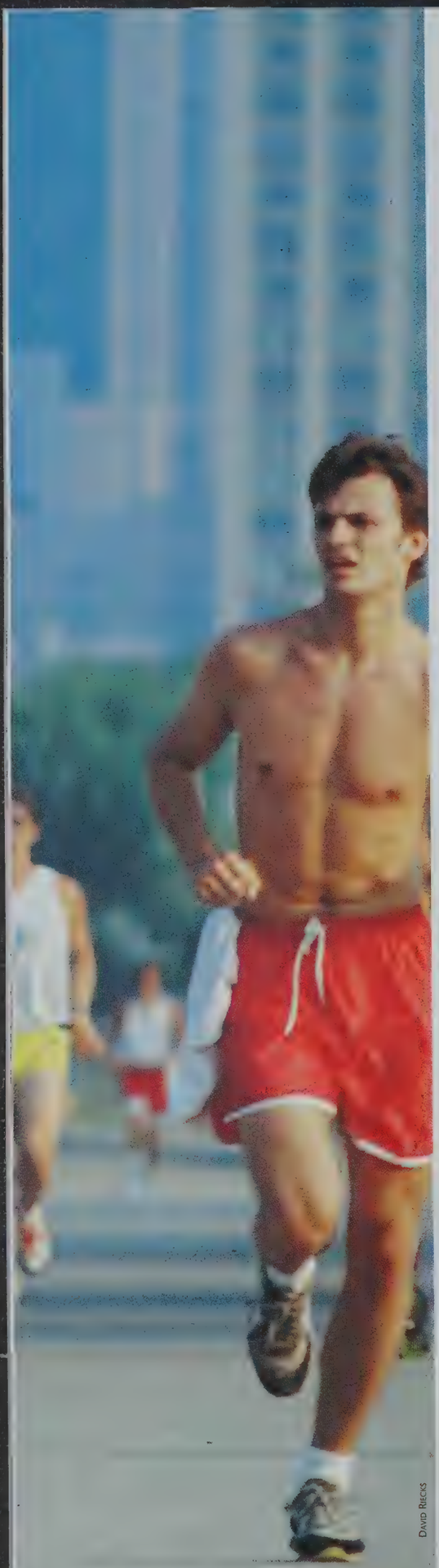
You may have more control over your health than you think. Indeed, health and wellness can be strongly influenced by an individual's own volition.

Choices. Life is full of them. How we spend our time and our lives is left largely up to us. That is one of the positives of living in a free and open society.

But the individual, seemingly insignificant choices we make, day in and day out, add up and set a pattern over time. Indeed, we are creatures of habit. And the sum total of our habitual behaviors—the ebb and flow of our lives—defines our lifestyle.

How much sleep we get, how much and what kind of TV we watch, what and when we eat, whether we walk or drive to the corner store. . . Our general attitudes toward life and fellow humans not only help define who we are as individuals but also influence our health and happiness.

Robert J. Reber and James E. Misner
Photography by David Riecks



David Recks

A look at the leading causes of death, in both Illinois and the nation, is revealing. The five main causes of death—heart disease, cancer, stroke, chronic lung disease, and accidents—are all related to lifestyles. And remarkably, the top two killers—heart disease and cancer—which account for nearly one-half of all deaths, are closely tied to lifestyles, particularly diet. Both the type and amount of fat ingested are important in the development of coronary heart disease. And it is estimated that diet plays a role in about 30 percent of all cancers, as either an initiator or a promoter of it.

The realization that our daily habits can profoundly affect our health and happiness has led to the development of a wellness concept that considers all aspects of our lives—both physical and mental. According to this holistic outlook, the whole may be more than the sum of the individual parts. We do not fully understand how individual positive lifestyle behaviors act in synergism to produce a healthier person or how the impacts of negative behaviors are compounded to destroy health. But we are learning.

Synergistic relationships between healthy levels of physical activity and nutrition are beginning to be understood. Increased muscle mass resulting from physical activity affects body metabolism that in turn influences nutritional well-being. Increased activity allows greater food intake, which affords more opportunity to take in essential nutrients.

Despite a growing awareness that healthy lifestyles have much to offer, many people are not practicing wellness. A total wellness approach takes time and commitment—variables at odds with society's fast pace. Too many people have been conditioned to look for answers that do not require time and effort, hoping against hope for a "quick fix." Pushing a lifetime commitment to wellness is a hard sell.

Our unhealthy living may be revealed to us in many ways. For some, it is that less-than-youthful figure that we see in the hallway mirror. For others, it is running out of holes in our favorite belt. Some of us have difficulty performing basic physical tasks without becoming exhausted or suffering muscle pulls and strains. Unfortunately, an all-too-common wake-up call results from a visit to our physician, who discovers high blood cholesterol or high blood pressure. And tragically, some of us do not get the warning until it may be too late—when a heart attack or stroke warns of unhealthy living.

Low-Calorie Diets Not Enough

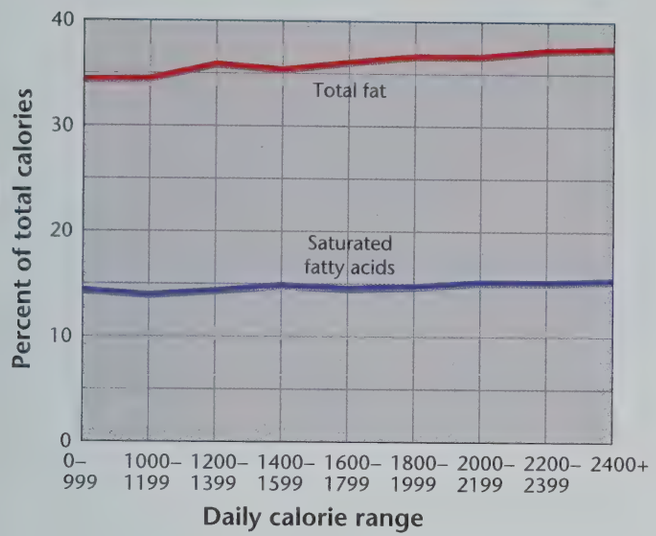
Once we realize that our lifestyles are wanting, a common reaction is to cut back on food intake. Unfortunately, more often than not this self-imposed limit to foods in general is not accompanied by any effort to increase physical activity. A recent study found that only about one-fourth of overweight men and women both reduced calories and increased physical activity. By far the most common response was to cut total calories alone (women, 64 percent; men, 50 percent).

Reducing total food calories without an accompanying increase in physical activity is an unfortunate trap that many individuals fall into. Such action may not necessarily lower fat calories relative to total calories, may result in poor nutrient intakes, and will certainly not result in a healthier body composition.

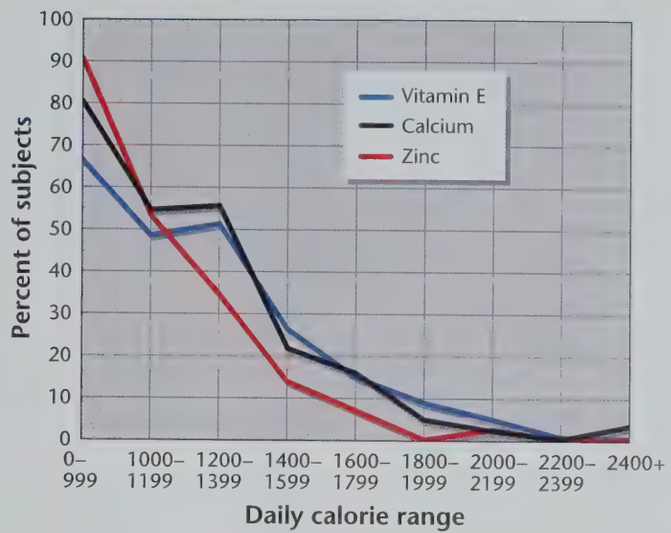
Self-imposed lower calorie diets may have less total fat, but the critical ratio between fat calories and total calories may remain nearly constant. When individuals cut back on all foods proportionally, which is often the case, the percent of calories from fat can remain well above recommended levels, as was shown in a recent study of more than four hundred middle-aged Illinois women (see graph at left on page 17).

Even diets that contained less than 1,000 calories daily did not meet the overall goal of less than 30 percent of total calories from fat. The average of 34.4 percent is well above this figure. Additionally, at the lower calorie levels, the percentage of calories coming from saturated fatty acids was well above the

Average Percent of Calories from Total Fat and Saturated Fatty Acids



Percent of Subjects with Poor Intakes of Vitamin E, Calcium, and Zinc



recommended level, which is less than 10 percent.

The point is clear. Cutting down on total calories alone will not reach these goals. A concerted effort must be made to reduce specific sources of fat.

Merely cutting total calories in an attempt to lose weight often leads to another problem—not enough total food may be eaten to supply all needed nutrients, particularly key vitamins and minerals. In the same study cited above, nutrient intakes were determined at different calorie levels. The intake of a nutrient was judged as poor if an individual received less than 60 percent of the recommended daily allowance for that nutrient. Data for vitamin E, calcium, and zinc are given in the graph at right above.

As can be seen, there is an obvious relationship between low-calorie diets and poor nutrient intakes. At the lowest caloric intake (below 1,000 calories), 90 percent of the women in the study had poor zinc intakes, 80 percent had poor calcium intakes, and 66 percent had poor vitamin E intakes. A similar trend was observed for other key nutrients. Women in this study had to consume at least 1,500 calories' worth of food on average to receive reasonable nutrient intakes. Similar studies with males indicate that 1,800 calories' worth of the average U.S. diet must be consumed to receive adequate nutrient intakes. Thus, strictly from a nutritional standpoint, merely cutting calories may result in poor nutritional intakes and will not necessarily lower percent of calories from either total fat or saturated fatty acids.

Another pitfall of having a lower calorie diet with no routine physical activity is that unhealthy body composition is not improved. Weight is lost, but the loss may include lean muscle in addition to fat. Physical activity is needed to maintain or increase muscle mass as fat is being lost. Otherwise, the person may weigh less but still be overfat.

You may be wondering where one must begin building a healthy lifestyle with the ultimate goal of physical and mental well-being. Remember, Rome wasn't built in a day. Two particular lifestyle choices make a difference and produce maximum benefit for the amount of effort:

- Reduce dietary fat
- Include healthy levels of physical activity

These are positive, critical choices every individual can make.

Cut Down on Fat

High-fat diets have been linked, either directly or indirectly, to coronary heart disease, certain cancers, and an unhealthy body composition—all major health problems. These three problems carry a heavy societal toll in terms of health-care costs as well as the suffering they inflict on affected individuals and families. Killing three birds with one stone is possible by opting for a low-fat diet.

Lower fat diets may also be lower calorie diets, but not necessarily so. In fact, cutting down on the fatty foods may "free up" calories for other nutrient-rich starchy foods such as whole-grain breads and cereals and root vegetables. The result can be a diet of the same calorie level but that is more nutrient-dense. Diets containing more starch and fiber have additional benefits. Higher starch diets promote greater storage of muscle and liver glycogen—a form of stored energy needed for most types of physical activity. Soluble forms of fiber (pectins, beta-glucans) are valuable in reducing blood cholesterol, probably via their bile acid binding capacity. Insoluble fiber (cellulose, hemicellulose) improves gastrointestinal function and may reduce risk of colon cancer.

All Pounds Are Not Created Equal

There is a problem with using body weight for a given height as a measure of health. A person can be "overweight" according to the standards. But if the extra weight is due to muscle and bone, that person could be very healthy. In similar fashion, someone's weight could be normal, but if the person has very little muscle and a lot of body fat, that person is unhealthy. A measure of body composition, such as percent body fat, tells us more about the health of a person.

The problem is determining body composition; it is not as easy as stepping on the scale. The most accurate method is underwater weighing, but it is an expensive and involved procedure that is appropriate only for research studies. Measuring subcutaneous fat with skinfold thickness calipers is a more practical method that has been used by health practitioners to determine body fatness. More recently, bioelectrical impedance shows promise of being a relatively straightforward, accurate method that can be used to assess percent body fat of most individuals. Some clinics and hospitals are using this method to determine body fat as an indicator of health.

David Riecks

Many approaches have been used to reduce dietary fat. One that has received much attention recently is the development and use of fat substitutes such as Simpless® and Oatrim®. Proponents of this approach believe we can have our cake and eat it too. They think the taste and texture of fat are so ingrained in our culture that the easiest approach is one of fooling Mother Nature—in this case our sensory perceptions. So far, however, the popularity of this approach has been less than its promoters had hoped. In addition, many questions have been raised, including: Where will we get fat-soluble vitamins if substitutes replace the real fat?

Another approach to reducing dietary fat, one that has broader support, is more holistic. This strategy considers the entire food chain from production to consumption and uses every opportunity to reduce total fat while maintaining the nutritional quality of the final food product. This approach explores the breeding, feeding, growth-regulation, and food-processing techniques that can be used to reduce fat in the livestock industry. This approach is not new and has already met with success. For example, the pork industry has made significant strides in reducing the fat content of their products since the 1950s.

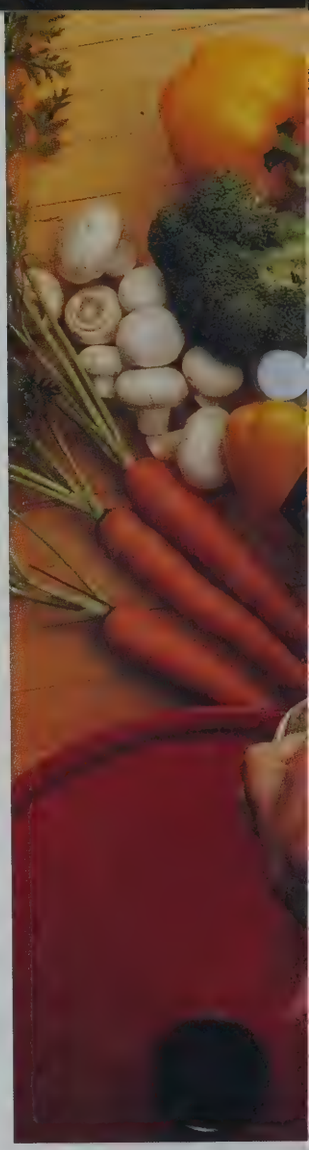
In the final analysis, you are responsible for your own food choice—to eat a diet loaded with fat or one that is much healthier. You must make a conscious decision to eat less fat. And it is not that complicated.

A step in the right direction is to use the new *Food Guide Pyramid* produced by the USDA Human Nutrition Information Service, which emphasizes more breads, cereals, fruits, and vegetables as a foundation. These lower fat plant foods replace higher fat foods in the diet. And choosing the lower fat alternatives from meat and dairy foods not only reduces total fat but also cuts down on saturated fatty acid intake.

Another important step is to limit your consumption of prepared foods, such as chips and baked goods, which can contain a lot of hidden fat. Reducing the amount of prepared foods in your diet can significantly lower your fat intake.

Finally, using healthier methods of preparation, such as broiling and baking instead of frying, will also lower total fat.

By taking responsibility and using these strategies, an individual can easily cut fat consumption to less than 30 percent of total calories.



Take a Walk

It has long been believed that physical activity is important to maintaining a healthy lifestyle and body weight. Recent research has demonstrated protective effects of physical activity on several chronic diseases, including coronary heart disease, hypertension, non-insulin-dependent diabetes, osteoporosis, cancer, anxiety, and depression. Physical activity reduces the risk of coronary heart disease and reduces body fat. Unfortunately, however, only about 22 percent of adults in the United States are as active as recommended. About 54 percent are somewhat active, but not active enough to achieve full health benefits. And at least 24 percent are completely sedentary; that is, they have no leisure-time physical activity.

Inactive people can take comfort in knowing that the greatest improvement in these health-related factors is obtained when sedentary people increase their physical activity level even slightly.

Preparation methods such as stir frying can add health—and zest—to your diet.

People who are already moderately active also improve health with increased activity, but not as much as sedentary people who get up out of their chairs and start getting physical activity. Also, it is never too late to increase one's physical activity. Recent studies indicate that previously sedentary middle-aged individuals who increase their physical activity live longer.

Why, then, are so few Americans physically active? Perhaps it is because previous public health efforts have emphasized the value of high-intensity activity. This has led to the perception that unless you engage in vigorous, continuous exercise for a prolonged period of time, you will not achieve health benefits. This perception may be based on previous recommendations for improving aerobic fitness. National guidelines recommended 20 to 60 minutes of moderate- to high-intensity exercise at 60 to 90 percent of maximum heart rate. Actually, scientific evidence clearly demonstrates that regular, less-intense physical activity provides substantial health benefits.

Current recommendations from the Center for Disease Control and Prevention in the American College of Sports Medicine are that an American adult should accumulate 30 minutes (approximately 200 calories' worth) or more of moderate-intensity physical activity over the course of most days of the week. Moderate-intensity activities that can contribute to this 30-minute goal include:

- Walking at 3 to 4 mph
- Cycling at or below 10 mph
- Swimming at moderate effort
- Golfing (pulling a cart or carrying clubs)
- Home care in general (cleaning, mowing the lawn, home repair, painting)
- Walking up stairs

One specific, easy way to meet this standard on a regular basis would be to walk 2 miles daily.

Persons who are not physically active should begin by including a few minutes of increased physical activity per day, building up gradually to 30 minutes per day. Those who are active on an irregular basis should strive to adopt a more consistent pattern of activity. It is not necessary, however, for the 30 minutes of activity to be continuous. *Thirty minutes of intermittent activity, spread throughout the day, appears to offer the same health benefit as continuous activity.*

Finally, because muscle strength and joint flexibility are important for maintaining physical function as we age, regular physical activity that develops and maintains muscle strength and flexibility is also recommended.

Celebrate Life

As far as we know, the rest of our galaxy is devoid of life. Not so for our planet. Earth is blessed with an incredible, incomprehensible blizzard of life forms we call biodiversity. All life is a valuable gift, but none is more precious or personal than our own. We have choices to make—choices that say much about our own integrity, philosophy, and will, or inner self. Self-destructive behaviors harm not only ourselves but also those around us. Choosing a healthy lifestyle is an act of celebrating our own gift of life as well as the many other forms of life that surround us.

Robert J. Reber, associate professor of nutrition, and James E. Misner, professor of kinesiology and head, Department of Kinesiology, College of Applied Life Studies

Building A New FRAMEWORK

The world is changing faster than most of us ever dreamed possible. Thanks to advances in communications and transportation, people around the globe who would have remained strangers in the past now have a chance to interact. As our world changes, it becomes much more complex, causing nations, communities, families, and individuals to become more interdependent.

To succeed in today's world, organizations such as the University of Illinois must keep up with the fast pace of change, staying responsive to the needs of people. This is a goal of the College of Agricultural, Consumer and Environmental Sciences, where research, teaching, and outreach programs are providing a more holistic framework for understanding the food and agricultural system.

This broader approach is a characteristic of "human sciences" research, which recognizes the need to evaluate products and systems in terms of overall human impact. In the past, new technologies and readily available natural resources allowed for continuous gains in lifestyle with minimal attention to long-term questions about efficiency of production, processing, and distribution. In contrast, today's focus is on how to make gains while minimizing both short- and long-term negative effects on human communities as well as on the environment and natural systems on which we depend.

Regarding the human aspect, we see examples of this new reality in the way that businesses are catering to the consumer. Key business concepts of "total quality management" and "continuous quality improvement" emphasize that every component of the system must contribute quality to the end product for the needs of the consumer to be met.

But the welfare of the consumer is only a small part of the picture. New products must be evaluated not only for safety and health effects but also for energy costs and environmental impact. Programs in the College are focusing on the well-being of families and consumers, *and* the sustainable development of our food-and-fiber industry.

A human sciences approach draws on a human ecological perspective, which provides for a holistic view of an organism's relationship to its environment. Whether the object of study is a plant, an animal, or a human being, each lives, develops, and reproduces in a reciprocal relationship with all other parts of the environment.

Many Environments Affect Humans

To understand human behavior, one must understand the environments in which humans live and their interdependence on them. Our environments include the natural environment with its physical and biological components, such as energy, soil, water, plants, animals, atmosphere, and climate; the human-built environment, which includes alterations and transformations made by humans for survival, sustenance, and attainment of human goals; and the behavioral environment, which includes the presence of other human beings in psychosocial relationships.

Human-science researchers focus on the functioning of the natural, constructed, and behavioral environments as they affect humans. An example of the human sciences perspective can be developed as a natural extension of the "sustainable agriculture" concept. Sustainable agriculture is a holistic systems approach to agriculture that typically elicits images of a more thoughtful approach to the ecological, economic, and social factors tied to agriculture. The concept of sustainable agriculture is based on the prudent stewardship of both natural and human resources.

Need for Sustainable Consumption

Americans have been developing a lifestyle of overconsumption for the past two hundred years. Per-capita consumption of resources in the United States is unequaled in the world. And even though most Americans recognize the need to change their patterns of consumption, such fundamental lifestyle changes will not come quickly or easily—unless forced upon us by social upheaval or natural systems collapse.

In 1991, total per-capita energy consumption in the United States was more than five times what it was in Germany and about nine times higher than in France. In 1989, a third of all motor vehicles in the world were registered in the United States. In a world where there is an average of one passenger car for every twelve people, the United States has more than one car for every two people, including children. Operation of these automobiles of course adds to the pressure on world fuel supplies and substantially increases pollution levels.

Two consequences of heavy consumption indicate a need for a change to what might be called sustainable consumption. First, if U.S. consumers continue to buy resources at such high rates, nothing will be left to buy. Production and other necessary and integrated parts of the system will be unable to satisfy our voracious appetites. Second, and more immediately, if some U.S. consumers continue to expend their private resources at levels in excess of their means, their own resources soon will become exhausted. Indeed, given the extent to which credit is used and facilitated electronically, some of those resources are nonexistent at the outset. Under such conditions, it is not difficult to imagine a collapse of the entire system.

Human Sciences Research Projects

An example of a project that demonstrates our new approach to human sciences research is the Functional Food Initiative. The College has always been a leader in the production of a safe, high-quality food supply. Through FFI, we are beginning to examine the potential to develop foods for specific health objectives.

For many years, Illinois agriculture has used soybeans as an important crop for protein and oil. More recently we have begun to recognize that soybeans contain micronutrients that may have specific benefits for health. Recent work in the College has focused on the ability of soy products to lower blood cholesterol. After nutrition researchers identify the one or more active ingredients that lower cholesterol, plant scientists may genetically engineer new plant varieties with increased levels of the active ingredients. Food scientists can then take the raw ingredients and develop food products that further feature the active compounds and are safe, economical, and desirable for consumers.

Another example of our new interdisciplinary human sciences research focuses on youth. Investigators in the area of youth risk behaviors—such as early sexual activity and alcohol and drug use—have been giving increasing attention to the role of the behavioral environment, considered at multiple levels. Early research in this area used an "individual-centered" model, in which youth risk behaviors were studied only as consequences of personality dispositions such as low self-esteem, risk seeking, unconventionality, and conduct disorder. The next wave of research began to examine adolescents in the context of their families, highlighting the role of factors such as parental monitoring, family cohesion, and discipline style.

The newest research direction focuses on neighborhood- and community-level factors. Studies have documented, for example, that community characteristics such as proportion of individuals in poverty and the unemployment rate influence youth risk behaviors, even when the corresponding individual-level variables (the individual's own income level and employment status) are taken into account. Thus, full understanding of youth risk behaviors requires recognition that individuals are embedded in family and community behavioral environments that can reciprocally influence each other. Current research and extension activities in the College reflect this understanding.

As we build the College's human sciences agenda in the coming years, we will seek to develop a better understanding of the interdependence between humans and their environments. Improving our understanding will allow us to provide better answers to those who are asking the questions—the families, the consumers, and the individuals that we serve.

Sara Douglas, associate professor of textile marketing and economics; Donald Layman, professor of nutrition; and Joseph Pleck, associate professor of human development

ILLUSTRATION BY LOREN KIRKWOOD


Bouncing
E. MAIN ST.

ng Back From Disaster

Aaron T. Ebata

When floodwaters rose along the Illinois and Mississippi Rivers and broke through levees in the summer of 1993, the American Red Cross, the Federal Emergency Management Agency (FEMA), and other disaster relief organizations were the most visible sources of help. Away from the media attention, the University of Illinois Cooperative Extension Service was providing its own support to individuals, families, and businesses and was using its local presence and collaborative relationships to provide assistance to local, state, and federal agencies and organizations.

Local CES staff were often among the first on the scene when levees were breached and recovery efforts began mobilizing. Providing support to flooded areas soon became a statewide initiative, with local CES staff as well as campus-based staff involved in a variety of efforts. By February 1994, CES had assisted on these fronts:

- Provided facilities and equipment to serve disaster areas.
- Developed and distributed information on health and safety, cleanup and rebuilding, agricultural recovery, disaster assistance and financial recovery, and child and family mental health issues. This information was made available via various media, including electronic communications on the Internet computer network.
- Provided educational programs for adults on food safety, cleanup, agriculture, business, mental health, and financial recovery.
- Conducted and provided technical assistance for inspections of flood-damaged structures.
- Organized youth activities, school-aged child care, and summer programs for flood victims; provided training for teachers and outreach workers on youth mental health issues.
- Facilitated disaster response and recovery efforts by providing assistance to individuals and businesses in completing paperwork or making referrals to agencies; matching victims with resources they needed; recruiting and organizing volunteers; and spearheading cooperative efforts with and among local organizations and agencies.
- Conducted applied research that will guide future efforts in preparedness, response, and recovery.

Following the flood, a CES Disaster Preparedness Task Force was formed to review the lessons learned from the flood and to take steps that would improve its ability to prepare for future disasters and recovery efforts. Since the flood, CES has:

- Established guidelines for CES staff roles and responsibilities during a disaster that will promote faster, more efficient response from the organization.
- Established a library of timely, research-based information that can be rapidly distributed.
- Enhanced electronic storage and distribution of information by establishing a World Wide Web site on the Internet with links to other disaster-related resources.
- Established partnerships with departments within the University, the Illinois Emergency Management Agency (IEMA), the Illinois American Red Cross, the Illinois Association of Regional Councils, the National Weather Service, and other agencies and organizations involved in disaster preparedness, response, recovery, and research.

These actions will ensure more rapid and coordinated efforts during times of need. When the next disaster strikes Illinois, the UI Cooperative Extension Service will be there to help.

Aaron T. Ebata, assistant professor of social development

To access the Illinois CES Disaster Resource home page on the Internet, use a World Wide Web browser such as Mosaic or Netscape, and point to the following address: http://www.ag.uiuc.edu/~disaster/disaster.html.

David Riecks

Researcher Michelle Wander works closely with landowners like Allen Williams of east-central Illinois to develop better methods for determining soil health.

Keeping the Soil Healthy

"The wealth of Illinois is in her soil, and her strength lies in its intelligent development." University of Illinois President Andrew Sloan Draper made that statement in 1894, and his words were inscribed on the frieze of Davenport Hall, built to house the Department of Agronomy.

The department is no longer in Davenport Hall, but a century later scientists still find inspiration in those words. They chose the same statement to introduce a multifaceted proposal for soil health research. The Illinois Soil Quality Initiative brings together not just scientists with expertise in soils and crop management, but also a communications researcher, microbiologist, forester, geologist, and agricultural economist. In addition, the project draws on the broad experiences of farmers, Cooperative Extension Service specialists, and representatives of agricultural and environmental organizations.

"There's a place for everyone," says Michelle Wander, a principal investigator and coordinator of the study. "We sought input from many people and groups, and in a sense, perhaps, we're part of something going on outside of the project. We're responding to an idea."

The idea is that a better understanding of how agricultural practices affect soil quality could lead to soil protection practices that protect the environment and enhance crop productivity. Scientists also hope to identify tools that farmers can use to make decisions about soil management.

An important component of the project is a dialog initiative, or exchange of ideas, among those concerned about soil quality. A survey of producers, farm managers, and other interested groups is one way researchers are gathering information. They will look for social and nontechnical considerations that might prove important in making soil protection practices easy to adopt.

This spring, researchers took to the field to evaluate tools and techniques for measuring soil quality. Over the next two years, they will work at five research farms around the state to develop baseline soil-quality data for Illinois. The data and strategies from this pilot study may prove useful later for a statewide soil-quality assessment.

The team also is evaluating tools for measuring soil quality on some thirty farms under real-world conditions where farmers use different tillage systems and make the management decisions.

This project is funded by the Illinois Agricultural Experiment Station's Strategic Research Initiative, a grant program that provides seed money to foster multidisciplinary research projects that result in practical outcomes.

Tina M. Prow, science writer, Agricultural Experiment Station

Putting Illinois in the Top 10 Research States

The Council on Food and Agricultural Research (C-FAR) is gaining momentum and attention. An idea of the University of Illinois Agricultural Alumni Association two years ago, this independent and diverse grassroots coalition is now thirty-five members strong and making progress toward improving state funding of food and agricultural research.

Responding to a strong case made by the C-FAR legislative committee last spring, Illinois Senator John W. Maitland and Representative N. Duane Noland sponsored Senate Bill 731, which called for a line-item increase in state funding for food and agricultural research. The bill was funded at $3 million, a first step toward the $15 million needed to move Illinois into the top ten states in state funding of agricultural research.

"We made an impact," says Lyle Roberts, chair of the C-FAR board and executive director of the Illinois Soybean Association.

Under provisions of the bill, the Illinois Department of Agriculture will allocate funds to four universities that conduct food, agricultural, and environmental research. The University of Illinois will receive 82 percent of the funding; Southern Illinois University, 11 percent; Illinois State University, 4 percent; and Western Illinois University, 3 percent. The bill requires the universities to work closely with C-FAR to identify research priorities. In addition, it requires the universities to fund a competitive grants program open to researchers outside their institutions.

C-FAR is committed not only to improving state funding of food and agricultural research but also to representing the public to research institutions.

Their efforts are supported in part by a two-year, $100,000 grant from the W.K. Kellogg Foundation awarded to Sarahelen "Sally" Thompson, an agricultural economist serving as a UI liaison to C-FAR. Last year, Thompson secured a Kellogg Foundation grant for a workshop that helped the coalition build a shared vision.

"The goals of Illinois C-FAR match what Kellogg wants to do," Thompson says. "They are trying to get each state to look internally at setting research priorities."

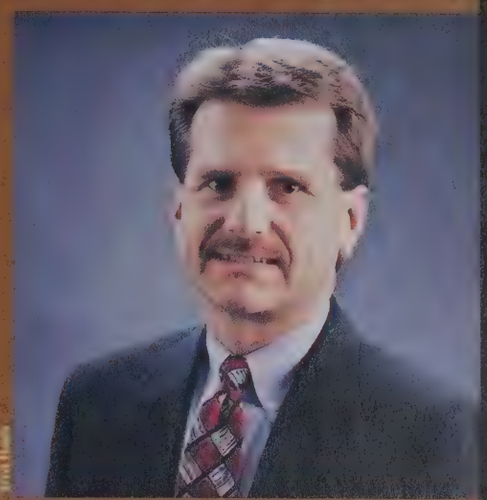
The W.K. Kellogg Foundation is a private organization that provides money to "help people help themselves." Earlier this year, Roberts made a presentation at meetings Kellogg sponsored to address public input into research priorities at land-grant institutions. Eight states asked for more information on C-FAR.

Broad areas of research priorities for C-FAR are:

- Markets for agricultural products and employment in the agricultural and food sector
- Economic development and management of agricultural and food systems in rural and urban communities
- Response to changing world food demands
- Nutrition, food quality, food safety, and health of humans
- Sustainable development and use of natural and human resources

Tina M. Prow, science writer, Agricultural Experiment Station

New Interim Dean for College



Our name—the College of Agricultural, Consumer and Environmental Sciences—isn't all that's new in the College. We also have a new interim dean—agricultural economist David L. Chicoine. Chicoine temporarily replaces W.R. "Reg" Gomes, who served as dean for seven years and left in August to become vice president of the University of California's Division of Agricultural and Natural Resources.

Chicoine headed the UI's Department of Agricultural Economics from August 1988 to January 1995. A native of South Dakota, Chicoine, 48, is known nationally as a policy economist with expertise in state and local government finance. He also is recognized for his work on farmland assessments and property taxes.

Chicoine began his new duties August 21, the same day the College's reorganization took effect. The reorganization includes redesignation of several departments in the College and the change of name to the College of Agricultural, Consumer and Environmental Sciences. Formation of a search committee is under way for finding a permanent dean by early 1996.

Watch for more news about College reorganization in our next issue.

University of Illinois at Urbana-Champaign
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Everything flows, nothing stays still.

–Heraclitus, quoted in Plato, *Cratylus*

If you look closely, you'll discover that we're changing our style. With this issue, *Illinois Research* begins a journey into a sea of change. This journey reflects the restructuring of our College, begun by departing Dean W.R. "Reg" Gomes and soon to be implemented by Interim Dean David L. Chicoine (see story, page 25).

The magazine will reflect our society's "hustle and bustle" by providing you with upbeat stories about the best and brightest people and programs in the College. Continue to look for changes in the next two issues. Our aim is to increase readability, respond to reader requests, and continue our mission of reporting scientific advances in the College. We welcome your thoughts and ideas.

ILLINOIS research

Research in Agriculture, Family and Consumer Sciences, Human Development and Nutrition, Natural Resources and Environmental Sciences
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign
VOL 37, NO 3/4 FALL/WINTER 1995

In the Spotlight:
Debut of Agricultural, Consumer and Environmental Sciences

THE NEW COLLEGE

'95 Farm Bill Wildlife on the Edge Rats in Space

THE COVER

Major innovations from the turn of the century to the present are often tied to research from a land-grant university, and the University of Illinois is no exception. With this issue of *Illinois Research,* we turn the spotlight on our UIUC College of Agricultural, Consumer and Environmental Sciences (ACES) and its evolution in the past two years.

More familiar to you as the College of Agriculture, this newly reorganized unit made the decision to restructure as part of its ongoing mission to create new knowledge in the areas of human factors and the agricultural and food system.

Our college and its land-grant legacy have a rich history of innovation and service in responding to current societal needs and anticipating future needs. With its name change, the college continues its impact by becoming more interdisciplinary and capitalizing on historical strengths. See pages 2 and 4 to read more about ACES and its people.

Cover design/illustration by Brian Cook and Alex Moore.

ILLINOIS RESEARCH

Published by the University of Illinois at Urbana-Champaign, College of Agricultural, Consumer and Environmental Sciences, Office of Research/Agricultural Experiment Station

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The Illinois Agricultural Experiment Station provides equal opportunities in programs and employment.

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ILLINOIS research
FALL/WINTER 1995 VOL. 37, NO. 3/4

n an Ever-Changing World

Perspectives:

Embracing Change in an Ever-Changing World

It's been quite a time for us. This past year, we changed our name to the College of Agricultural, Consumer and Environmental Sciences (ACES). At the same time, I became interim dean, and our faculty and staff began reorganization under a seven-department structure (see page 8).

Together we began the 1995–96 academic year with almost 2,000 students, a flurry of new-semester activities, and major undertakings related to restructuring. Now, some six months later, I am looking at our evolving college with calmer eyes.

There's no denying change is part of all that we are and do in today's world. Webster says to change is "to give a different course or direction to a process or entity." This is an apt description of our activities in instruction, research, and outreach programs in ACES.

People sometimes comment that names become longer after companies, agencies, and institutions reorganize. This is most apparent when several groups merge or are bought out by a parent company. In our case, the new name reflects a blending of past and future, not only where we've been, but also where we're going.

If you look closely, you will see the same familiar faces, instruction, and programs in ACES, along with our reputation for achievement that ranked us among the top ten agricultural colleges throughout the nation in a survey recently reported in *Farm Futures*.

Change began several years ago when human and environmental issues became an integral part of the college. I view this as an exciting opportunity to expand our influence on society by helping devise truly sustainable agricultural and resource-management strategies. This means we will do our part to discover and develop more sustainable and environmentally friendly ways of producing, processing, and distributing the world food supply.

The agricultural and food system continues to be the focal point of our programs. Human factors continue to be at the center of issues facing agriculture and will continue with clearer recognition in our changing global economy.

New research programs are an example of how added dimensions are changing our college. I'm thinking of two examples, the Special Research Initiatives (SRI) and the Council for Food and Agricultural Research (C-FAR). The SRI concept, developed during the past two years, challenges our scientists to participate in team-based research. The goal of such research is to achieve practical solutions to issues affecting people at home and on the farm. These team-based initiatives capitalize on integrated strengths as researchers tackle "big-picture" problems.

C-FAR also illustrates a new way of planning and organizing research. A coalition of more than thirty Illinois organizations, C-FAR strengthens the relationship between the researcher and the end-user of research to target specific food, agricultural, rural, and resource issues.

These changes enhance and build on our traditional style of ongoing research, which typically has capitalized on individual and small-group efforts from a single discipline. These current research innovations add new dimensions to our

scientific abilities and mirror our new college name and mission.

In much the same way, this issue of *Illinois Research* illustrates an evolutionary process. The publication has become a significant voice for informing you about all college programs as well as highlighting our research. As *Illinois Research* further evolves in future issues, you will see increased coverage of college programs in our target arenas—the classroom, the laboratory, the UIUC campus, the counties of Illinois from Rockford to Cairo, and the international market.

Our intent is to deliver usable information to you in a new, visually exciting format. We're making textual changes to enhance message delivery and ultimately may change our publication's name to better reflect our active college.

I'm excited about the new contemporary format and focus and would like to know your thoughts about these changes. This evolving interactive communications interface will strengthen our opportunity to provide innovative and important information about ACES. I look forward to hearing your ideas as we begin a new year serving Illinois.

David L. Chicoine

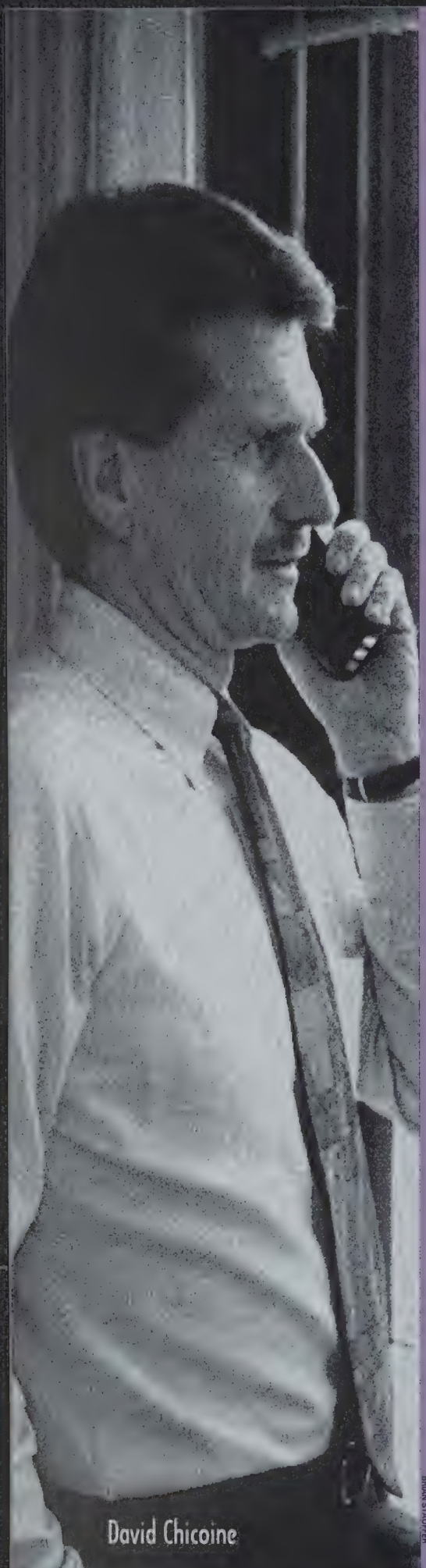
David L. Chicoine, interim dean, College of Agricultural, Consumer and Environmental Sciences

entering a new era

charting a course built on tradition and innovation

LISA SHEPPARD

Members of the College of Agricultural, Consumer and Environmental Sciences have begun a journey down a somewhat different path. Collectively they are helping steer the college in a direction that infuses new ideas into traditionally strong programs. Since college reorganization took effect in 1995, life in the college has taken on a new dimension. Students are preparing for the future by supplementing long-standing studies such as crop production and food science with fresh subjects such as ecosystem management and bioengineering. Likewise, faculty are moving into more interdisciplinary research to find answers to complex systems-based problems. And Extension specialists are redevoting themselves to bringing the fruits of research to the public, both the rural sector and the rapidly expanding urban sector. While they embark on this new journey, faculty, staff, and students see a bright future ahead. The following interviews provide a vision of reorganization from the personal side as we hear from five people who are intimately involved in the reorganization process.



David Chicoine

BRIAN STAUFFER

"It is a time of celebration."

David Chicoine, Interim Dean

What are your job responsibilities?

As interim dean, I am the chief executive officer of the college. I provide overall leadership to the college, working with associate deans, department heads, student and faculty leaders, and the faculty.

How long have you served as interim dean?

Since August 21, the day the college reorganization went into effect. Previously I served as head of the Department of Agricultural Economics.

How will the college reorganization be implemented?

The reorganization is now in a phase when the details of change must be addressed. Searches are under way for permanent administrative leadership—department heads in five of the seven departments, an associate dean for academic programs, and a permanent dean. At the same time, the faculty is looking at academic programs at the undergraduate and graduate levels and working together on research and Extension programs in the new seven-department organization.

When will curriculum and administrative changes be implemented?

As quickly as possible, but with careful thought. I am optimistic that within two years most of the changes will be completed. The department head and dean positions will be filled before the 1996–97 academic year begins.

What are the benefits of reorganization?

There are two major benefits in reorganizing the college. The first is that we now have an organization that clearly recognizes the program strength and breadth of the college and permits us the opportunity to communicate effectively about the college across campus, to the citizens of Illinois, and to the Illinois food and agricultural sector. Second, it better aligns the college relative to funding realities and positions us to make better and more efficient use of the resources supporting our programs.

What does college reorganization mean to you?

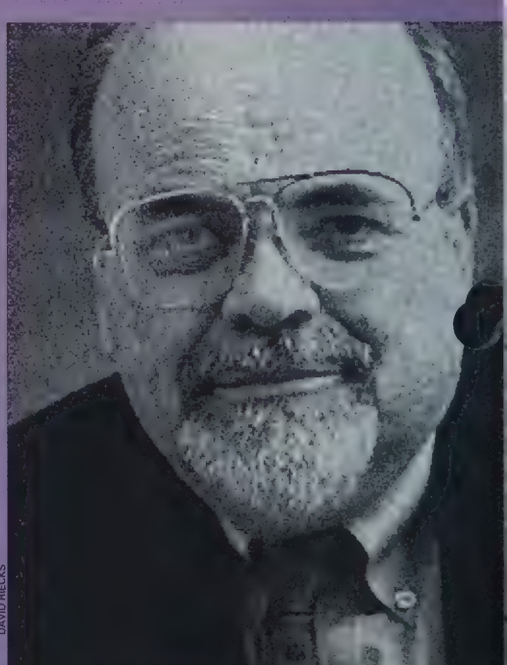
I think it is a time of celebration. It is an opportunity to celebrate the beginning of a new college with five new departments plus two departments—Animal Sciences and Agricultural Engineering—that were not impacted.

What are the benefits of changing the name to the College of Agricultural, Consumer and Environmental Sciences?

The name recognizes all the programs that have been part of the college for quite some time. We will still be known to some for a long time as the College of Agriculture. It is up to us to emphasize the several dimensions and components of the college that are now reflected in the college name.

What are the advantages of serving as interim dean?

It has given me additional opportunities to realize that the faculty, students, and others in this college are just great individuals to work with. It's a privilege to work with people who are of this caliber, with high energy levels, great creativity and sincerity, and all of the other attributes one likes to have in individuals with whom you interact on a daily basis.



DAVID RIECKS

I've also come to appreciate more than ever the very deep and sincere support across the state of Illinois for the University of Illinois in general, but particularly for our college.

What do you like to do when you're not serving in your official capacity?

I like to watch Illini sports, work in the yard and garden in the summer, and read in the winter.

"Everybody realizes that this is new, it's different, and it will take some getting used to."

John van Es
Interim Head, Department of Human and Community Development

What are your job responsibilities?

I am in charge of bringing together faculty members and programs from different units, including agricultural communications and education, human development and family studies, rural sociology, and 4-H/youth development. As a new department, we are beginning to look at the opportunities and develop some balance between the allocation of resources and the programs that we have and would like to develop.

What is your biggest challenge?

Undoubtedly the biggest challenge as interim department head is to bring together faculty members who come from different academic and professional backgrounds. I am trying to have the faculty work constructively to build a new identity without losing the old ones.

How have faculty and staff reacted to the reorganization in your department?

People have been extremely cooperative. Everybody realizes that this is new, it's different, and it's going to take some getting used to. We are trying to move forward in an environment of restricted resources. So we must redefine, rearrange, sort things out, and set priorities.

What do you like best about working in the college?

I like the fact that the college mission includes working with and for the people of Illinois. I believe very strongly in research, but at the same time I get a great deal of satisfaction out of the outreach activities that are associated with research and with the college in general.

What are your academic interests?

My area of interest, both for research and Extension work, is community and economic development. I have been studying the changes that are taking place in rural Illinois. Many rural communities have been severely affected by the changes in agriculture, mining, manufacturing, and retail, and they are coping in different ways.

How can Extension help solve the problems of rural communities?

Among other things, research can be applied to help small towns that are struggling economically. For example, tourism is perceived as a sector in the economy that has some opportunities in the rural areas. We are studying the communities that are successful in attracting tourists to find the qualities that encourage tourism in rural Illinois.

What books have you read lately?

Skins by Adrian Louis, *Stranger Music* by Leonard Cohen, and *Albert Speer: His Battle with Truth* by Gitta Sereny.

John van Es

DIGITAL PHOTO EFFECTS BY BRIAN COOK AND MARISA MEADOR

Dianne Noland

BRIAN STAUFFER

"I am developing a new course that will fit beautifully into the new curriculum."

Dianne Noland
Teaching Associate, Department of Natural Resources and Environmental Sciences

What are your job responsibilities?

I teach three undergraduate courses every semester on floriculture and floral design and a general horticulture course in the summer. I also advise from twelve to twenty students every year.

How long have you been in the position?

I am starting my sixteenth year.

What is your advice for students who are not sure what they want to do yet?

I advise students to take a broad view of the field. I like to have them do a little bit of everything in the curriculum as freshmen and sophomores, then specialize once they find that area they think they are going to like.

What teaching approach do you emphasize in your classes?

I like the team approach in my advanced classes. Sometimes it works really well, and other times it flops. But students need to know that life is about working in a team. I give them a problem, and they have to work it through together.

What are your greatest challenges?

My biggest challenge is finding the time to do everything I want to do, which is spend enough time with each student, prepare my courses, and develop new courses. Another challenge is to keep up with everything that is new. I teach two related but diverse areas: floral design and landscaping. So I must stay updated on all the new supplies and suppliers for both fields.

How does the college reorganization affect your position?

Right now, the curriculum is unaffected by the reorganization. I'm still teaching landscaping and floral design no matter which department heads the curriculum. Faculty will soon analyze the courses in the new department to see if there is any duplication.

I am developing a new course that will fit beautifully into the natural resources and environmental sciences curriculum. I have been working on "Landscaping with Native Plants" for about eighteen months. Native plants are a hot topic right now. These plants are more drought-resistant, and they save resources because you don't have to overwater and baby them.

What are benefits of the reorganization in your department?

Our new department is now 20 percent of the college. As a larger unit, we will possibly have added resources and equipment.

Do you have any concerns about the reorganization?

I worry that the name *horticulture* is lost. When I hear the name of the department, Natural Resources and Environmental Sciences, I think of forestry—I don't think of horticulture. Fortunately, the name *horticulture* will still appear in the curriculum.

What are the benefits of working in the college?

Definitely all the friendly people who have similar backgrounds. In comparison, I like working at the university because of all the diverse people. In my course for nonmajors, I get ninety completely different individuals every semester. I like that diversity.

What is your avocation?

Gardening is my vocation and my avocation. I have gardens on all sides of my house. I'm working on a tree-lined, flower-lined driveway. Eventually, I would like to have a botanical arboretum.

What books have you read lately?

A historical book, *Women of Courage* by Margaret Truman, and *Joshua* by Joseph Girzone.

ACES Departments and Their Subject Matter

Agricultural and Consumer Economics
Agricultural economics, consumer economics, textiles and apparel, marketing of textiles and apparel

Agricultural Engineering
Agricultural engineering, agricultural mechanization

Animal Sciences
Animal sciences

Crop Sciences
Agronomy, plant pathology

Food Science and Human Nutrition
Dietetics, food industry and business, food science, hospitality management, human nutrition

Human and Community Development
Agricultural communications, agricultural education, human development and family studies, rural sociology, 4-H/youth development

Natural Resources and Environmental Sciences
Agricultural entomology, fiber science, forestry, horticulture, soils

STEPHEN HUNTS

"I think reorganization is a way for us to survive."

Meg Webster
Senior, Department of Agricultural and Consumer Economics

Which classes are you currently taking?

Family economics, employee benefits, insurance, logic and reasoning, and an introduction to floral design. I'm also taking a correspondence course in estate planning to obtain a certified financial planning designation.

What is the most interesting class you have taken in your college career?

An advanced financial counseling and planning course. We had the opportunity to work with actual clients—students and staff who volunteered for the project. We made suggestions on how they could improve their financial situation. Most of the clients were advised on paying off credit-card debt.

Which aspect of consumer economics interests you most?

Financial management and planning. I have taken both finance courses and courses in consumer and family economics. Finance courses provide the numerical background necessary for technical analysis. Consumer economics gives you the basic overview of numbers

as well, but it also focuses on the emotional side of money and how it impacts the family.

What are your career aspirations?
I've considered different aspects of financial planning, and I'm still looking. The possibilities include working in a bank or trust department, a financial planning business that offers a variety of financial services, an employee benefits department, or working with a foundation in fund-raising efforts.

How do you feel about merging agricultural economics and consumer economics into one department?
I view it as positive. There is a very close parallel between the two fields. Basically the only difference I see is that consumer economics focuses on the family and consumer side, and ag economics focuses on the grain and livestock industries. Although my major is on the consumer side of economics, I joined the Agribusiness Association to get another perspective on finance and merchandising.

I also think the reorganization is a way for us to survive. My major has a smaller number of students. If the reorganization makes it possible for my major to remain a part of this campus, then I'm all for it.

Where is your hometown?
Toulon—a small town north of Peoria. I grew up on a grain farm and raised Suffolk sheep.

Have you read any good books lately?
It's nice to read a fiction book or mystery, but lately my reading has been concentrated on studying for classes. I've read many books on long-term care insurance for my internship. I'm currently reading an interesting book called *A Fatherless America.* It deals with the issues of single-parent families and the idea that Americans discount the importance of fathers in families. I'm also studying for the certified financial planning designation, so I'm reading several books on estate planning.

"The idea behind reorganization is to make us an efficient college."

Rebecca McBride,
Assistant Dean, Office of Academic Programs

What are your job responsibilities?
Each of the four assistant deans of the college share daily responsibilities for directing student traffic in the office. We assist students with everything from "My grandma died and I need to get on the next bus home," to "I need to drop a class and it's after the deadline," to "I'm going to graduate in January and I don't know if all my requirements are filled."

I also provide leadership in the area of student applications and records and working with advisers. Last fall, we received 1,129 applications. We admitted 764 students and enrolled 484 students.

What is your greatest challenge?
Evaluating credentials of young people in high school and deciding whether the applicants are academically ready for college coursework. It is difficult for an 18-year-old to decide on career aspirations, but part of the success of the student at the University of Illinois is interest in the courses. Students who are admitted to programs they have no interest in will not likely be motivated to go to class.

For students who are not accepted to the college, we try to provide them with an alternative plan to get them here. Just because a student is denied admission as a freshman doesn't mean he or she can't enroll as a transfer student.

What is your role in reorganization?
My responsibilities include helping students look at the opportunities available in the new college.

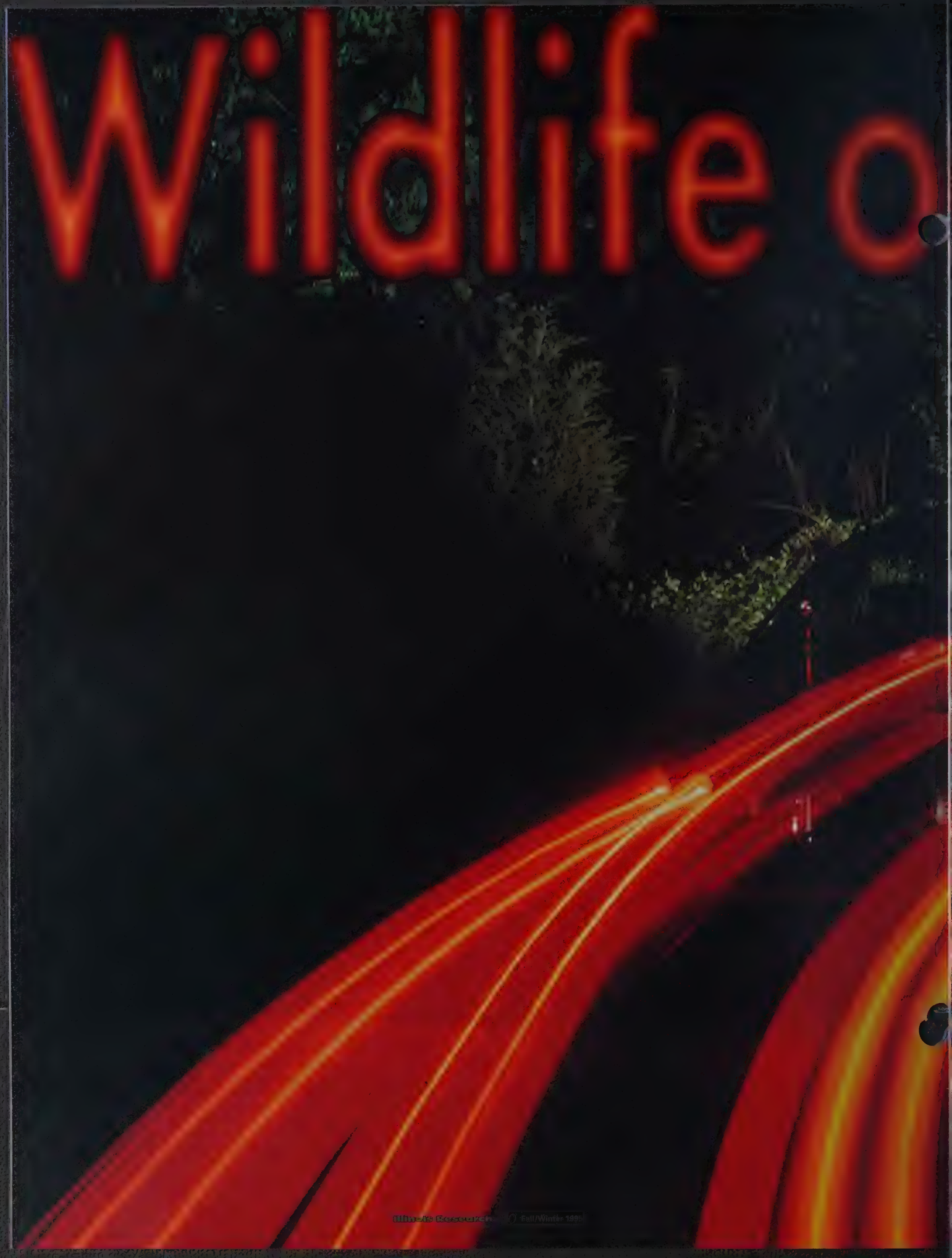
Will undergraduate programs change for students enrolled in the college?
The programs still exist, but students are now under a new departmental office. We had to reassure a few students that their major will continue until they graduate. We're not going to start eliminating programs. I think there will be some consolidation of programs, which makes sense. The idea behind the reorganization plan is to make us an efficient college, showing that we can respond to the concerns and issues that the campus administration puts forth.

What are the benefits of working in the college?
People in the college care about the educational process. The university is becoming more focused on the undergraduate experience, but this college has done so for a long time. It is exciting to know that there are people on the cutting edge of research, but you can call them up and ask them to advise an undergraduate in class selection or school research projects, and they are willing to help.

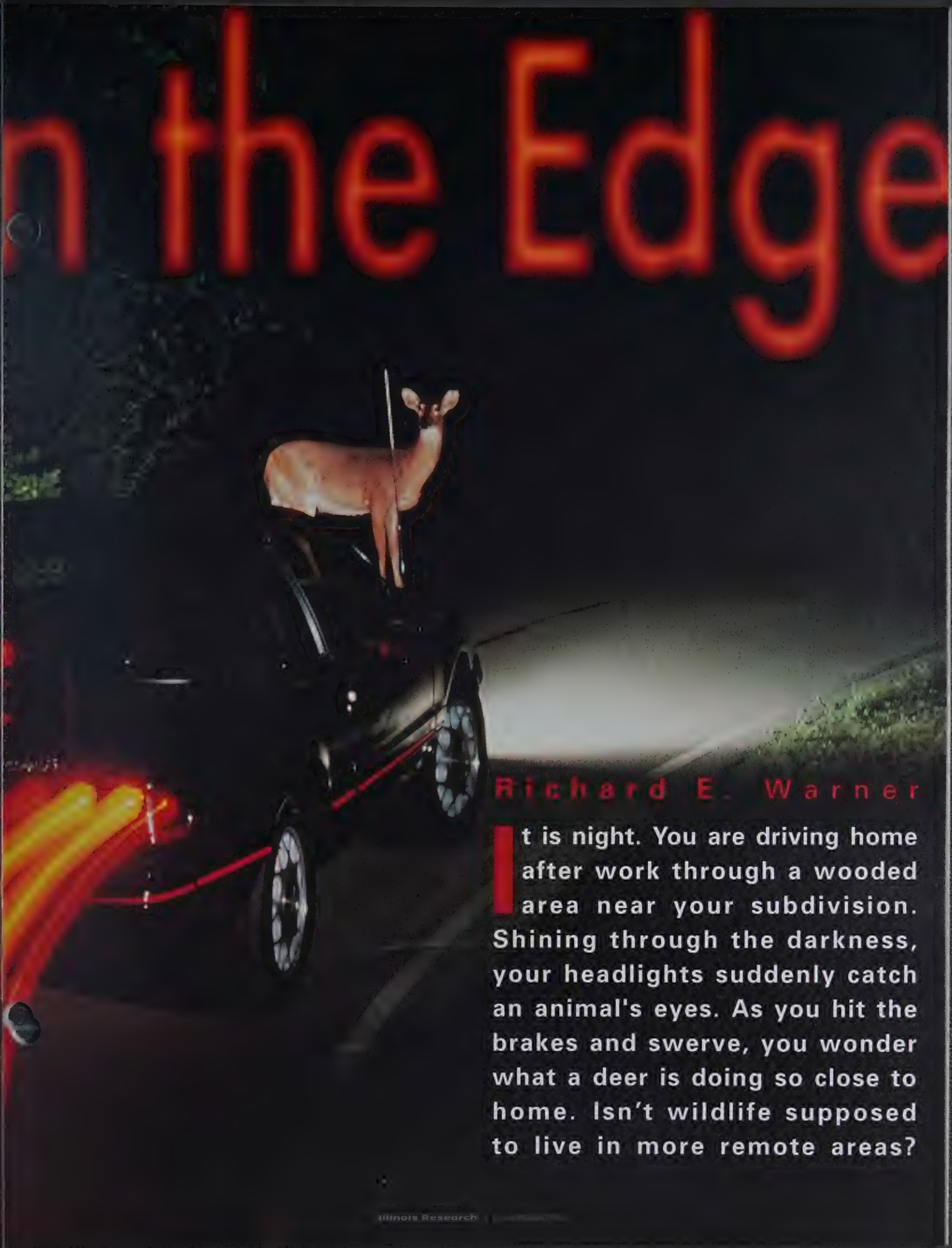
What books have you read lately?
I recently finished one of James Herriot's collections as a tribute to him. I enjoy reading animal stories and was so heartbroken when he passed away. Recently I also read *Uh-Oh* by Robert Fulghum and *The Cat and the Curmudgeon* by Cleveland Amory.

Lisa Sheppard is a communications specialist in the college's Information Services office.


BRIAN STAUFFER
Rebecca McBride


Wildlife o

n the Edge



Richard E. Warner

It is night. You are driving home after work through a wooded area near your subdivision. Shining through the darkness, your headlights suddenly catch an animal's eyes. As you hit the brakes and swerve, you wonder what a deer is doing so close to home. Isn't wildlife supposed to live in more remote areas?

DIGITAL PHOTO EFFECTS BY BRIAN COOK AND ALEX MOORE

One of the ironies of modern life is that as humans continue to alter the natural environment in urban areas, many species of wild animals are actually faring better in these more urban environments than they are in more rural areas. A major reason for this phenomenon is that intensive agriculture has caused extensive loss of wildlife habitat in recent decades. As a result, many wildlife species traditionally common in farmland environments have declined precipitously.

Managing wildlife at the urban-rural edge can help alleviate habitat problems for many species, especially those that thrive in small patches of grassy and woody vegetation. These areas where different ecosystems overlap, known as ecotones, are often rich in the diversity and abundance of plant and animal life. Communities in Illinois with extensive tree canopies are also attractive stop-over points for "neotropical" birds (migratory species) in need of replenishing their energy reserves during spring and fall migration.

It is fortunate that at the same time many wildlife species are showing preference for areas of dense human population, society is in turn becoming increasingly appreciative of wildlife. For example, during the 1980s the number of Illinois citizens participating in activities related to wildlife observation doubled. The increasing participation in wildlife-related recreation, much of it taking place close to home, is creating a greater demand for knowledge about how to manage wildlife in suburban settings. This bodes well for the preservation of these species.

Until now, wildlife professionals have given relatively little attention to the urban-rural interface. In fact, our knowledge about how to optimally manage such settings for wildlife is minimal. Therefore, a few municipalities in Illinois have deliberately integrated wildlife management with the other goals of landholders and the community.

Frequently, intervention by wildlife managers is most needed where ecosystems have been radically altered because of human encroachment. This certainly applies to the edge of urban and rural areas. Naturally occurring checks and balances often are no longer intact. Consequently, some wildlife species become overabundant, while others become rare or extirpated.

Filling the Knowledge Gap

Wildlife specialists at the University of Illinois at Urbana-Champaign are beginning to focus attention on the urban fringe. The location of their research is the UIUC campus and adjoining environs, an ideal place to begin honing our knowledge about wildlife on the edge of urban settings.

Like many urban communities, the people of the community comprising the UIUC campus have a strong interest in landscaping and wildlife within their community. In addition, the UIUC South Farms (2,275 acres devoted largely to agricultural research) and adjoining residential developments provide a land-use buffer similar to sprawling subdivisions and hobby farms in counties collaring larger metropolitan regions. This buffer zone between Urbana-Champaign and large-scale cash grain farms has diverse cover types such as small pastures, orchards, grain fields, and forage legumes. The buffer also abounds with well-landscaped subdivisions. These small patches of habitat are connected by streams and other corridors that may further enhance their attractiveness to wildlife.

Another reason for our researchers' interest in the subject of wildlife on the urban fringe is that wildlife-related studies at the UIUC are increasingly popular, and the proximity of this research to the UIUC campus will allow for convenient access by students. Moreover, the opportunity to manipulate land use on UIUC holdings over the long term will allow for experiments that will produce reliable knowledge of how to manage wildlife in these settings.

Phase 1 Research: Foxes and Rabbits

During the past couple of years, preliminary research at UIUC has started on two mammalian species that are important to the ecological food webs of the Prairie State—the red fox and eastern cottontail. Wildlife biologists have already confirmed for rabbits what the casual observer has long suspected: traditionally abundant in rural Illinois, the cottontail now occupies farm landscapes in sparse numbers. The rabbit research on the UIUC South Farms and adjoining areas has confirmed that suburbia is now the main refuge for cottontails.

Rabbits that have been collared with miniature radios show some intriguing patterns of movement between residential areas and the buffering habitats of the South Farms, effectively ensuring that breeding bunnies are well-dispersed in the community. As many gardeners will agree, the cottontail may be faring too well as a city slicker. As the checks and balances for the cottontails in human-dominated settings are better understood, biologists hope to be able to recommend practices that will moderate rabbit numbers in the gardens of suburbia or, alternatively, produce more cottontails on farms where they are a sought-after game species.

STEPHEN HUNTS

Richard Warner has devoted much of his life to studying the relationship between humans and wildlife in Illinois.

Graduate student Patrick Hubert, left, and research specialist Phil Mankin monitor wildlife on the edge of campus in Urbana.

Although the red fox study has just begun, researchers are taken with the importance of this creature in the rural-urban interface. On the South Farms, for example, foxes may be the primary predator holding rabbits, and perhaps other small mammals, in check. Without this important predator, the overabundance of small mammals in gardens and orchards would probably be more pronounced. There is also reason to believe that the fox has been declining in the farm landscapes of Illinois. Researchers hope to determine whether foxes thrive in the urban fringes of Illinois, where foxes raised in suburbia disperse to, and their overall importance in ecological food webs.

Where We Go from Here

In the future, the management of wildlife at the rural-urban interface can be enhanced by better knowledge. The important questions seem endless. What are the most effective and natural controls for overabundant species? How important are travel corridors for wildlife? What landscaping and other management practices can landholders and municipalities employ to sustain species that are rare or endangered? What are the important issues related to the spread of wildlife diseases to humans? Do wildlife toxicology studies have important implications for humans?

The emerging studies of wildlife at the edge of rural and more developed parts of Illinois should answer these and many other important questions, ultimately allowing us to sustain our rich wildlife heritage into the next century, which will also benefit a human populace increasingly taken with these issues.

Richard E. Warner is an interim associate director in the Office of Research/Agricultural Experiment Station. He specializes in natural resource issues.

The 1995 Farm Bill Affects You!

Tina M. Prow

Every few years one of the most misunderstood pieces of legislation is debated in coffee shops and offices, in hallways and newspapers, and finally on the U.S. House and Senate floors.

The misunderstanding about the "farm bill," says policy specialist Robert Spitze, is that it is only about farms and politics. The truth is that the bill affects many Americans directly and every American indirectly and reflects what society wants in food and agricultural policy.

Spitze, professor emeritus with the Department of Agricultural and Consumer Economics of the College of Agricultural, Consumer and Environmental Sciences, has witnessed debate and development of food and agriculture bills over the past fifty years.

"It's tradition to refer to this policy as the 'farm bill,' and the media report it as the 'farm bill,' but it has roughly three times the budgetary impact on food assistance compared to what it does on farm program costs; then throw in food safety, environment, conservation, and trade.

Don't be caught by surprise. Your food prices and our nation's land and water quality are just part of what is at stake. The food and agricultural policy being debated in Congress affects everyone—not just farmers. Ultimately the content of this legislation reflects the opinions of citizens who decide to roll up their sleeves and get involved.

"So, the so-called farm bill is anything but a farm bill," he says. "It's public policy for our society."

Spitze characterizes the change in food and agricultural policy over the years as "evolutionary," changing over time to reflect society's concerns of the day. He likens the mood of the current debates to 1960, 1977, and especially 1985, in the call for change.

The 1985 debates, he recalls, focused on target prices and price supports set in 1981 as a response to rampant inflation. The recession of the following years, however, provoked government to adjust the support levels downward.

"In each of the twenty bills I've watched, I've heard that 'it's time to change,'" he says. "Today, those voices are with us again and are slightly stronger and more persuasive because of sensitivities to attitudes about the budget deficit and the degree of governmental action."

Farmers Need Less Paperwork, More Flexibility and Incentives

The size of the government budget and amount of government involvement in food and agricultural programs is a concern of Charles Grotevant, Jr. From his 700-acre farm in Kankakee County, south of Chicago, he sees reducing the federal deficit as an important goal for policy makers. However, he is concerned that agriculture may be targeted for disproportionately large cuts because of its high visibility but seemingly low relevance to a majority of the population.

"We in agriculture want to be part of the solution and we're willing to take cuts, but we want to see other kinds of programs take a fair share of the cuts too," Grotevant says.

Topping Grotevant's list of changes needed in food and agricultural policy for the latter part of the 1990s is flexibility in planting to allow farmers to respond to market forces, world trade, and environmental requirements. He would like to see reductions in government-required paperwork, a low-interest loan program to replace direct payments to farmers, cash incentives for conservation measures to improve stewardship, and more U.S. Department of Agriculture funding to research at land-grant universities.

"There seems to be a wave of thought that farmers get big dollars out of farm programs," he says. "There are abusers, just as there are abusers of every other program, but the biggest benefits of the farm bill, ultimately, go to society. We're 2 percent of the U.S. population, but we bring the cheapest, safest, and most abundant food supply in the whole world to 98 percent of the U.S. population—some people have lost sight of that."

1995 Bill Takes Shape

Providing abundant, safe, and affordable food and fiber to Americans and ensuring stability of the farm economy and agriculture have been primary goals of food and agricultural policy developed in the United States since the 1930s, says P. Scott Shearer, USDA deputy assistant secretary for congressional relations. He says that USDA Secretary Dan Glickman also is looking for policy that "provides a safety net for the American farmer; continues to have a very strong trade title to continue to provide for the expansion of trade; and has a strong conservation title to maintain the great strides in conservation that agriculture has made over the past ten years."

Responding to changes in the agricultural economy, the USDA in the most recent farm bill (which was still being debated when this issue went to press) supported greater flexibility in planting so farmers could better take advantage of changes in national and international markets. Responding to a call for less prescriptive treatment of programs, the USDA also submitted plans for simplifying programs of the food and agricultural policy of 1995 so that the programs are easier to administer and to implement.

"More and more groups—agriculture, consumer, environmental, commodity, and others—are involved in food and agricultural policy, and we meet with them to hear their concerns and goals," Shearer says.

"It's an important part, we think, of the overall process that goes on in policy making."

Shearer, who also worked on the 1981 food and agricultural policy legislation as an aide to Senator Alan Dixon of Illinois, then a member of the Senate agriculture committee, reflects that the 1981 farm bill was "off the floor and headed to conference committee" by the end of September. "We're very late in the process this year," he said late last September. "The goal of everyone is to have a bill completed and to the president by the end of the year [1995], but it could be later."

Part of the delay was caused by disagreement over budget cuts, Shearer says. The Republican budget called for $13.4 billion in cuts, while the USDA budget proposed $4.3 billion in cuts over seven years. The difference between those two figures for Illinois amounts to about $750 million, he notes.

Shearer observes that voting seemed to be more partisan than in the past. Looking at the makeup of policy makers, he also notes that Congress is more urban than ever due to the 1990 census, reapportionment, and redistricting. Out of 435 members of the House of Representatives, thirty-five have a farm population of 5 percent or greater and 114 have no farmers in their districts. In addition, a majority of members were new enough that they had never been through food and agricultural policy debates.

"The urban Congress is a reflection of society, and so it is increasingly important that we show the relationship of what agricultural policy means to the public as a whole," Shearer says.

"Beyond commodity programs for farmers, there's research, education, conservation, the food stamp program, food safety, and rural development. It's policy for the rural economy and the national economy. There are trade items in the policy, and with $53 billion in ag exports, that has a major impact on the American economy," he adds. "It's way beyond policy for a 2 percent segment of the American population."

Bill Becomes More Comprehensive

The pressing needs of society have caused food and agricultural policy to become more comprehensive over the years. In 1971, the bill was twenty-nine pages in length and covered price and income support programs for commodities. In 1990, the farm bill was more than eight hundred pages in length and contained twenty-five titles, including conservation, commodities, credit, environment, research, trade, and food stamps.

"The bills reflect the times in which they were passed," Shearer says, "concerns of the farm and agricultural economies, the public's concerns of the time, and also the politics of the day."

The responsiveness of government to the citizens is democracy in action, Spitze says.

The so-called farm bill is anything but just a farm bill. It's public policy for our society.

Increasingly since the post-1940s, citizens act through interest groups—in the 1990s, one can find an interest group "for every conceivable interest," he suggests. The proliferation of interest groups is due in part to communication technologies that allow people to easily work together from far-flung locations.

Also, the increasing complexity of policy over the years required interest groups to begin targeting specific issues—which led to policy that was more comprehensive and detailed, Spitze observes.

Everyone Needs to Participate

"What we all have to remember is that the 1995 policy is going to be a policy of the public of this country," he says. "It's not the policy of 'governmental officials,' or 'interest groups,' or 'political leaders.' They are all involved, but our democratic processes ensure that ultimately the decisions over time get made by the public who choose to participate.

"In our system, the government is the public. The 1995 policy is going to speak to a wide variety of important public issues," he adds, "and that makes for an increasingly comprehensive bill."

Whether the policy was settled in the fall, as hoped, or this spring, as now projected, is irrelevant, Spitze says. What is important is that the debate about what society wants takes place.

"It provokes me to urge us to remember that it does matter," he says, "that we do have concerns; that we do express them; that we do enter into the arena of decision making, of compromise, and of conflict management.

"It does matter to me as a consumer what happens on the farm; what happens to the landscape across the country; what's in the water system that my family and I drink; what kind of income flows to different groups; what the prices are that I pay for food; that there are starving people and hungry children who will be our future citizens; how we relate to other countries in terms of trade—because that's going to affect the degree of peace on this planet.

"These things do matter, so we must keep informed and we must let our representatives in Washington know what we want for our public policy."

Tina M. Prow is a communications specialist in the college's Information Services office.

Where to Go for More Information

One of the easiest ways to keep up on the farm bill is to stay tuned to local, regional, and national media, which do a good job of providing news of this legislation. For more in-depth information, including a historical perspective, take a look at the following publications:

1995 Agricultural and Food Policy Options and Consequences, by Harold D. Guither, University of Illinois College of Agricultural, Consumer and Environmental Sciences, AE-4707, 164 pp. To order a copy, call (217)333-1811.

Blacks in Rural America, by Joyce E. Allen-Smith (co-editor) with James B. Stewart, 1995, New Brunswick: Transaction Publishers, 202 pp. Note especially Introduction, Chapter 1, and Chapter 9. Available at your local library or bookstore.

Choices, by the American Agricultural Economics Association. This quarterly magazine includes policy articles written for a non-specialist audience. Call (515)233-3202 for subscription information.

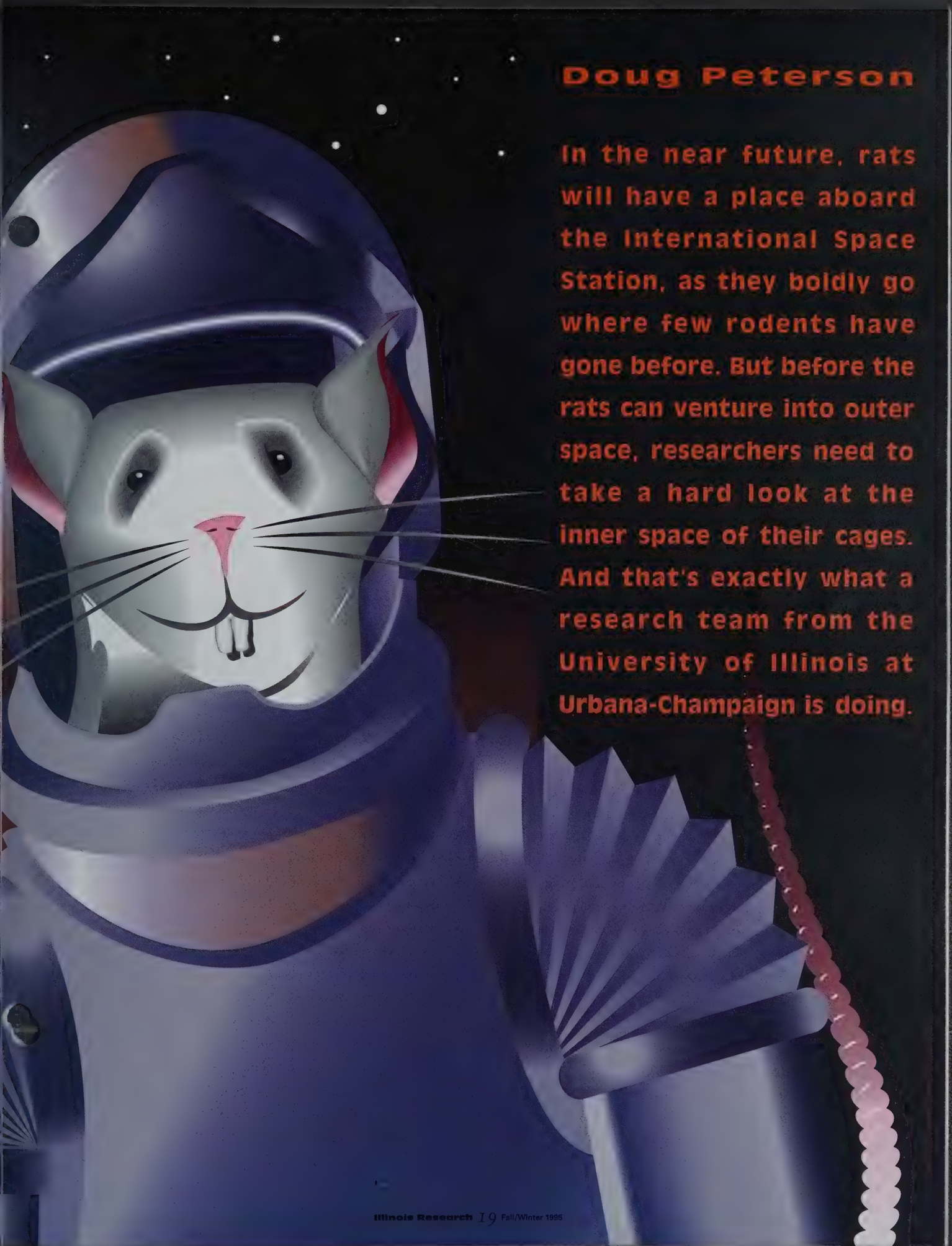
The Economics of Food Assistance Programs, by Laurian Unnevehr et al., ERS Staff Paper 9507, 1995, Washington, D.C.: U.S. Department of Agriculture. Available from your local library or the USDA.

Food, Agricultural, and Rural Policy into the Twenty-First Century, by Robert G.F. Spitze (co-editor) with Milton C. Hallberg and Daryll E. Ray, 1994, Boulder: Westview Press, 406 pp. Available at your local library or bookstore.

U.S. Farmers' Preferences for Agricultural and Food Policy, by Harold D. Guither, Bob F. Jones, Marshall A. Martin, and Robert G.F. Spitze. University of Illinois College of Agricultural, Consumer and Environmental Sciences, B787, 1994, 57 pp. To order a copy, call (217)333-2007.

Also check out the following Internet site for the latest developments in farm bill and other federal legislation: *http://thomas.loc.gov/.* Inspired by Thomas Jefferson, this site is provided by the Library of Congress.


RATS
IN SPACE



Doug Peterson

In the near future, rats will have a place aboard the International Space Station, as they boldly go where few rodents have gone before. But before the rats can venture into outer space, researchers need to take a hard look at the inner space of their cages. And that's exactly what a research team from the University of Illinois at Urbana-Champaign is doing.

The International Space Station, a collaborative effort of the United States, Russia, Japan, Canada, and Europe, is an engineering wonder, with the first components scheduled for launch in late 1997. However, to include rats aboard the station requires designs that go above and beyond what are used in laboratories on Earth. High-tech cages, or "advanced animal habitats," as they're called, need to provide a well-regulated environment that is as contaminant-free as possible. Otherwise, critical research results that relate to the effects of low gravity on humans can be compromised.

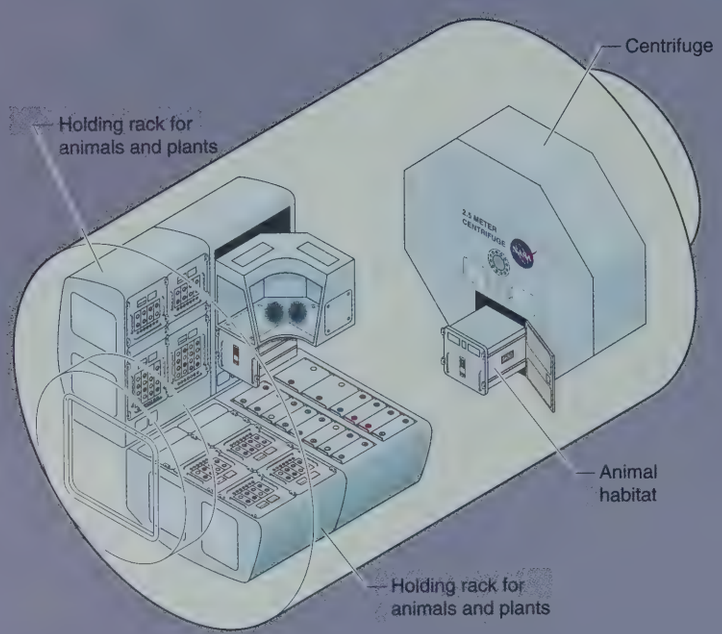


ILLUSTRATION BY M.R. GREENBERG

UIUC researchers are designing a comfortable animal habitat for the "centrifuge module" aboard the International Space Station.

Designing the Perfect Habitat

In low-gravity space, regulating the surroundings and reducing contaminant levels in cages pose unique challenges because rats and wastes tend to stay airborne, says Gary Riskowski, a UIUC agricultural engineer involved in the project.

Riskowski and UIUC animal scientist Paul Harrison, with assistance from Harold Gonyou (now a research scientist at the Prairie Swine Center, Saskatoon, Canada), have been monitoring the air quality in mock-ups of the rat habitats, and they have come up with new designs to improve the welfare of the animals. It's all part of a unique multidisciplinary research team effort being carried out at the university's Bioenvironmental Engineering Research Laboratory.

According to the research team, the rats will live in habitats aboard what is called the "centrifuge module" of the space station, and they will be part of various studies dealing with the long-term effects of low gravity, or microgravity. Depending on where the rats are placed on the rotating centrifuge, the animals will experience different degrees of gravity, offering clues as to how humans will cope with long-term missions in space.

On short-term missions, many astronauts have had reactions to microgravity that would give anyone second thoughts about the joys of floating through a room. Most astronauts have complained about headaches, nausea, and malaise, and some have even had backaches as the disks separating their vertebrae expand in a low-gravity environment. Long-term flights pose even greater risks as muscles—including the heart—weaken from lack of exercise. Bones lose density and weaken, while red blood cell counts decrease.

The Dream of a Space Station

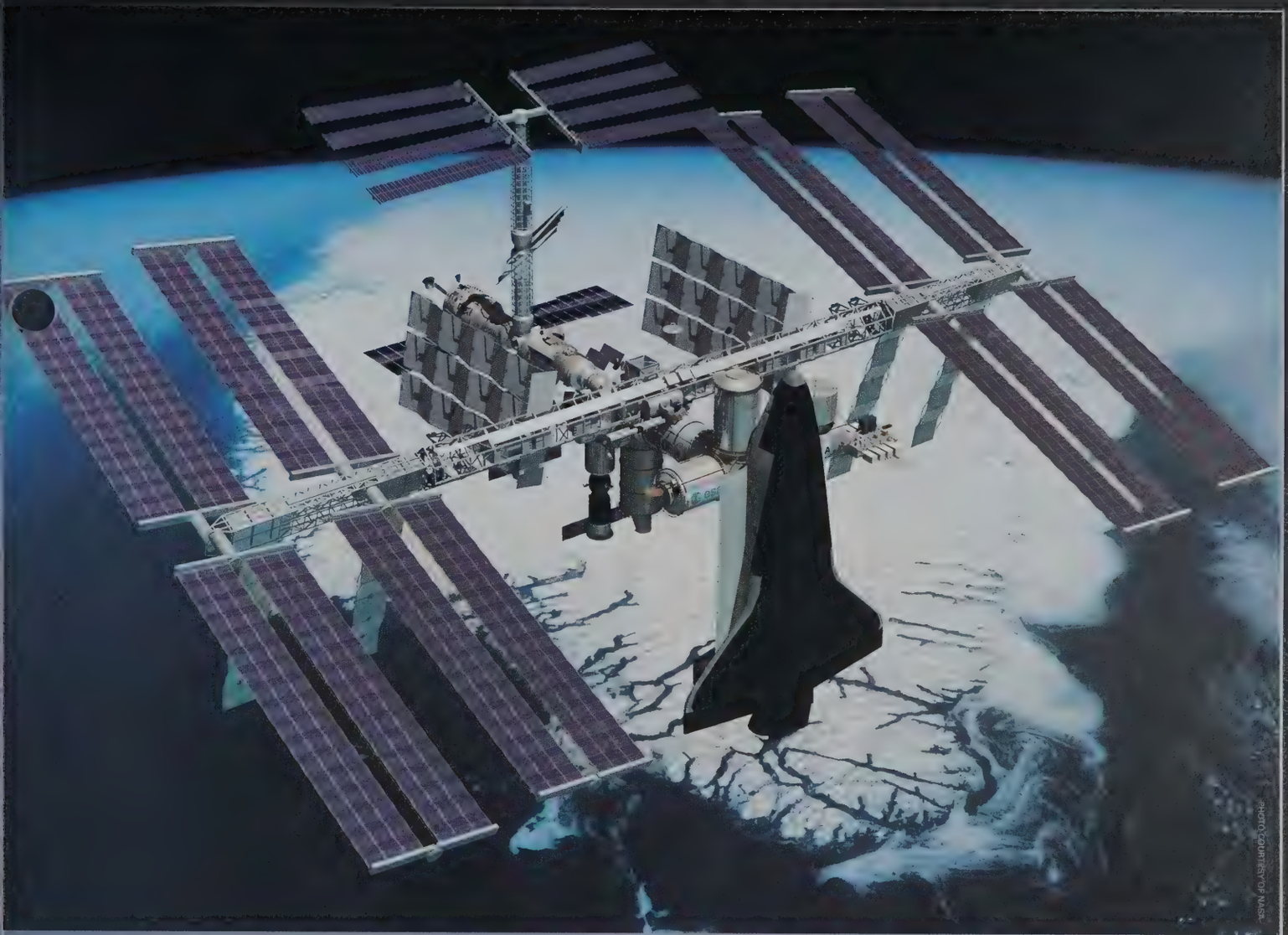
Despite problems posed by microgravity and other obstacles, Americans have been dreaming about a permanent outpost in space long before Captain Kirk and Luke Skywalker. One of the earliest dreams came in the form of Edward Everett Hale's 1869 science fiction story "The Brick Moon," which envisioned the use of a human-occupied satellite to help navigate ships on Earth.

At one time (1959), the development of a space station by the United States even stood as a greater priority than a mission to the moon. As it turned out, of course, the United States did turn its eyes to the moon, while the Soviet Union put a stronger emphasis on space stations.

In January 1969—the same year that American Neil Armstrong first set foot on the moon—the Soviets docked Soyuz 4 and Soyuz 5 in Earth's orbit. And these two satellites, they declared, constituted the first space station. After that, the Russian space program became progressively more ambitious, culminating in its Mir space station. Launched in 1986, Mir is still used and will play a role in the creation of the International Space Station. U.S. astronauts will have up to two years of access to Mir in preparation for building the new station.

The United States had its most extensive experience with long-term life in space with the Skylab space station, launched in 1973. Skylab hosted three different crews that year and into 1974, but it was never intended for resupply or refueling. Its fall from orbit in 1979 came unexpectedly early, generating a lot of interest and apprehension about where pieces of Skylab might come crashing down.

The current space station effort, the International Space Station, dates back to 1982, when the National Aeronautics and Space Administration (NASA) founded the Space Station Task Force.



A space shuttle is docked to the International Space Station in this computer-generated representation. Various modules can attach to the long rectangular keel, and rows of solar panels generate power.

The station's design has been continually modified, as budget constraints come into play, but the basic idea has remained the same. The station will feature a long rectangular keel onto which various modules attach, as do solar arrays (rows of solar panels) to generate power. The station will accommodate six people while it follows an orbit 230 nautical miles above Earth.

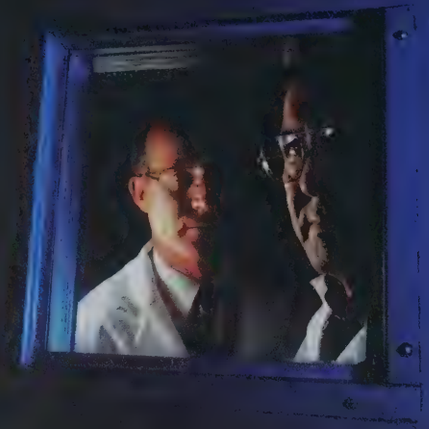
Two modules for the station, both being produced by the United States, are in the works—a laboratory module and the centrifuge module. The laboratory module was completed in fall 1995 and is scheduled for launch in 1998, whereas the centrifuge module is scheduled for launch in a year most appropriate for this particular space odyssey—2001.

Mission Happy Rats

This brings us back to the "advanced animal habitats" that will be home to laboratory rats on the space station. Rats are "edge users," which means they like to be in contact with their surroundings. And no matter how big the cage, they usually end up in groups, up against the edges of their habitats. Taking this into consideration, Harrison, Riskowski, and Gonyou came up with two cage designs that provide more "edges" than just the outer part of the cage. One design featured two L-shaped partitions in the center of the cage, and another featured a series of wire "bunk beds" on each side of the cage.

The research team evaluated the stress levels of animals in each of the newly designed cages, as well as in an ordinary "barren" cage. After conducting blood tests and tissue analyses, they did not find any significant differences in stress, but they did discover that the rats had a strong preference for the cage with partitions.

To "ask the animals" which type of habitat they preferred, the research team combined different cages and allowed the rats free access to the different styles and sizes of habitats. Then they videotaped and observed which cage the animals used. The rats far and away preferred the partitioned cage, as animals gathered in a collective heap, up against the partitions in the middle of the habitat. The outer portion of the cage provided easy access to food and water.



Gary Riskowski of the Agricultural Engineering Department, left, and Paul Harrison of the Department of Animal Sciences are contributing to NASA's efforts to find clues about the long-term effects of microgravity on humans.

STEPHEN HUNTS

"Remarkably, we found that bigger is not always better," Harrison says. "The rats chose social interaction and security over extra floor space, therefore defining what their needs are when it comes to caging. Guidelines for laboratory animal cages require a certain number of square inches of cage area per animal, but NASA is interested in the quality of animal habitats, not just quantity."

In addition to considering cage design, Riskowski and Harrison measured the amount of heat, moisture, and dust generated by the rats in their cages, as well as (you guessed it) manure, urine, and gases such as ammonia. The habitats handle this unpleasant bit of business by sending air through the cages to pick up contaminants and carry them through some formidable filters. Riskowski and Harrison have been studying how different air velocities moving through the cages affect both the animals and contaminant levels.

One way NASA hopes to reduce the production of waste by laboratory rats in space is by feeding them rodent food bars instead of the typical rat pellets used on Earth. Harrison and Riskowski studied the rodent food bars and found that the rats were able to convert the food to energy at rates comparable to the pellets.

The main difference between the two diets, Harrison says, was in the way the rats balanced water and nitrogen levels in their body. With the food bar, they ate more feed and drank less water; with the pellet diet, they drank more water and ate less feed. As for taste, the rats favored the food bars over the pellets, demonstrating that space food can be palatable—at least for rats.

What Next?

The welfare of laboratory rats aboard the space station is vital, the UIUC researchers stress, because if contaminated cages or an unhealthy diet leads to health problems for the rats, those factors could throw off the results of low-gravity research. And, as Harrison notes, the microgravity studies on the space station will have long-range implications for the space program.

"The effect of microgravity will have implications for a moon station farther down the line and for any possible trips to Mars," he says.

Or, as one official put it back in 1993, "If you want to go to Mars, there is only one known show stopper, and that's the long-duration effects of space exposure on the human system."

In addition to providing information on the side effects of life in space, microgravity research will shed light on more Earth-bound concerns, such as birth defects, high blood pressure, heart disease, osteoporosis, balance disorders, and other diseases.

"No other lab will be able to mimic microgravity conditions like the one that will be aboard the International Space Station," Harrison adds. "This will certainly be the most unique laboratory in the world—or out of this world."

Doug Peterson is a communications specialist in the college's Information Services office.

Space Station Milestones

1928 Herman Noordung, an Austrian, publishes the first space station blueprint.

1959 A NASA committee recommends that a space station be developed before a trip to the moon.

1961 The moon landing is given priority over a space station.

1969 The Soviets dock Soyuz 4 and Soyuz 5—the first space station. American Neil Armstrong walks on the moon.

1973 The United States launches the Skylab space station.

1974 The last Skylab crew heads home. In all, Skylab hosted three crews for stays of 28, 56, and 84 days.

1979 Skylab falls from orbit.

1981 The first space shuttle flies. The shuttle is conceived as a vehicle for hauling people and materials between Earth and a space station.

1983 The shuttle carries Spacelab 1 into orbit. Spacelab provides experiment facilities to researchers from many countries for up to two weeks—an interim space station capability.

1984 In his State of the Union address, President Ronald Reagan calls for a space station.

1985 Japan, Canada, and the European Space Agency agree to participate in the space station project, which eventually is named the International Space Station.

1986 The Soviets launch Mir, a space station that is still in use.

1994 Phase 1 of the International Space Station begins. Russian cosmonaut Sergei Krikaleve serves as a mission specialist aboard the space shuttle Discovery.

1995 Discovery maneuvers around the Russian space station Mir.

PHOTO COURTESY OF NASA. DIGITAL PHOTO EFFECTS BY ALEX MOORE.

PHOTO BY J.R. HOLBERT, COURTESY CIBA-GEIGY CORP.

Funk Farms, 1942. (L to R) Eugene Jr., Lafayette, Eugene Sr., Paul, and Ted Funk.

Farewell to a Friend...

Eugene D. Funk, Jr. (1900–1995)

Life is sweet because of friends we have made
And the things which in common we share.
We want to live on, not because of ourselves,
But because of the people who care.

It's in giving, and doing, for somebody else
On all that life's splendor depends,
And the joys of this life, when you've summed it all up,
Are found in the making of friends.

— Eugene D. Funk, Jr.

The poem above, penned by Eugene D. Funk, Jr., aptly describes his relationship with the college. Gene, co-owner and one-time leader of the Funk Brothers Seed Company of Bloomington, Illinois, died at the age of 95 on September 17, 1995. He attended our college in the early 1920s and joined other members of the Funk family in support of the college throughout the better part of this century.

In the late 1800s, Eugene Funk, Sr., worked with the college on the development of hybrid corn. Later family contributions include a major endowment by Gene's brother, Paul, which established a premier awards program for college faculty and staff, and a $1 million endowment by the family that will go toward construction of the ACES Information and Alumni Center.

We acknowledge the rich legacy of the Funk family throughout the years and celebrate the life of this agricultural visionary, Eugene D. Funk, Jr.

Nancy Nichols, communications specialist, Information Services

Watchful Eye on Water Quality

Recent research conducted at the College of Agricultural, Consumer and Environmental Sciences has revealed some potential concerns about a commonly used agricultural chemical. According to the findings, atrazine, a herbicide that has been detected in 114 of 135 water sites sampled in Illinois, causes chromosome damage in hamster ovary tissues at levels below the maximum exposure level of 3 parts per billion established by the Environmental Protection Agency.

"The results provide evidence for further investigation of the potential health risks of consuming water contaminated with atrazine," said A. Lane Rayburn, associate professor in the Department of Crop Sciences.

Chromosome breakage, which causes structural changes in DNA, has been associated with some forms of cancer and birth defects.

Using a technique called flow cytometry, Rayburn examined molecular changes that take place at concentrations of atrazine commonly found in surface water in Illinois. Previous studies that found chromosome damage were based on high levels of exposure not normally found in the environment.

"At this point, however, we do not know what the results of the observed breakages would be," Rayburn said.

He also tested the herbicides bentazon and simazine. Neither caused measurable chromosome damage. The studies were funded by the Illinois Groundwater Consortium.

Rob Wynstra, communications specialist, Information Services

State Legislators Visit the College

Ongoing research—from the information superhighway to new plant and animal food products—provided the main course November 28 for some twenty Illinois state legislators touring the College of Agricultural, Consumer and Environmental Sciences. All were members of either the Illinois House or Senate agricultural committees.

"We're not here out of fear or because we are upset about something," said State Representative Duane Noland of Blue Mound, chairman of the House Agriculture and Conservation Committee. "We're here to learn."

State Senator Harry "Babe" Woodyard of Chrisman, chairman of the Senate Agriculture and Conservation Committee, agreed.

"We came to try to learn a little more about what the University does and we've learned quite a bit today," he said. "For my part, I did not realize before the amount of research that is going on every day at the university and here in the College of Agricultural, Consumer and Environmental Sciences."

During the day of the tour, the legislators met with University of Illinois President James Stukel; Chancellor Michael Aiken; David L. Chicoine, interim dean of the college; and other administrators, faculty, students, and researchers at the university.

DAVID RECKS

Touring state lawmakers acknowledged to university leaders a need to know more about the expanding research projects of the new College. (L to R) Jack Widholm, professor of plant physiology at UIUC; Senator Harry "Babe" Woodyard, chairman of the Illinois Senate Agriculture and Conservation Committee; H. Kirk Hard, associate president for governmental relations at UIUC; Steve Phipps of Phipps Farms, Chrisman; and Patrick Fucik, Illinois Department of Agriculture.

The legislators' tour included demonstrations of both the StratSoy project, a computer-assisted application of information technology to enhance soybean producer profits, and applications of computer technology in undergraduate education.

Bob Sampson, communications specialist, Information Services

BRIAN STAUFFER

Aerial view of Champaign County wetlands ecosystem.

SRI Update

The Special Research Initiatives (SRI) grant program, part of the Office of Research, provides college researchers with start-up funding for systems-based research that is multidisciplinary and outcome-oriented. Current research projects on aspects of tourism in rural Illinois, soil quality, and ecosystem-based management for agricultural watersheds are under way. New projects will focus on pork quality and development of soybean lines for seed oil.

Tina M. Prow, communications specialist, Information Services

New Soybean Infobase

The soybean industry can access current market information, find out about soybean cyst nematodes, and locate companies that make soy flour through StratSoy, an electronic information project developed at the College of Agricultural, Consumer and Environmental Sciences.

Located at *http://stratsoy.ag.uiuc.edu/stratsoy.html*, StratSoy is a communication and information system for the soybean industry, but accessible to anyone on the Internet. Visitors to this project can find information on news and activities of soybean offices around the country. Project developers also comb the Internet for links to universities, libraries, government, and other resources around the world that might be of interest to agriculture.

In addition, StratSoy offers an interactive "Ask the Experts" service. This allows users to e-mail questions to specialists in areas ranging from production to utilization to human health.

StratSoy also offers a Soybean Research Database for coordination and integration of check-off–funded research activities. Features of the database will allow users to organize, search, and retrieve information. It is intended to help soybean organizations minimize unnecessary duplication of research, identify needed research activities, and obtain information for marketing of research findings.

BRIAN STAUFFER

(L to R) StratSoy strategists Darrel Good, Sally Thompson, and Floyd Davenport.

The StratSoy project was developed by Sarahelen "Sally" Thompson, Steven Sonka, and Darrel Good, all with the college's Department of Agricultural and Consumer Economics. StratSoy is funded in part by a grant from the United Soybean Board. The StratSoy home page is being built and maintained by the Office of Computer Coordination, University of Illinois Cooperative Extension Service. The Texas A&M University Agricultural Market Research Center collaborated on the research database.

Tina M. Prow, communications specialist, Information Services

University of Illinois at Urbana-Champaign
Office of Research/Agricultural Experiment Station
211 Mumford Hall, 1301 West Gregory Drive
Urbana, IL 61801

College of Agricultural, Consumer and Environmental Sciences

Landscape of Opportunity and Optimism

Our new ACES logo symbolizes the college's history, location, mission, and organization.

Reading the elements, the global shape suggests sunrise, furrows, and growth. ACES is integrated, in harmony, with the shape of the landscape. There is a feeling that ACES is part of the circle, part of the cycle.

The three bars outside the circle stand for teaching, research, and outreach, our three main college goals. They also represent the three areas mentioned in the college name: Agricultural, Consumer and Environmental Sciences.

Within the circle, four white bars alternate with three black bars to create seven bars, which stand for the seven newly reorganized college departments.

ILLINOIS research

Caring for life

Future Waves of Grain

A Place of Discovery

Partnership Illinois

THE COVER

A caring hand almost cradles the earth. Bathed in light, the hand symbolizes a nurturing approach to the world and its creatures.

ILLINOIS RESEARCH

Published by the University of Illinois at Urbana-Champaign, College of Agricultural, Consumer and Environmental Sciences, Office of Research/Agricultural Experiment Station

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ILLINOIS research
SPRING/SUMMER 1996

ectives:
ervice tradition

CES Built on Solid Foundation

As a new century approaches, change is all around us. Here on campus, our college has a new name and a new departmental structure. The Illinois Cooperative Extension Service reorganized in the early 1990s, and it's possible that the Chancellor's Commission on Extension will soon recommend a few more changes to ensure that CES can continue helping people put knowledge to work for many years to come.

But even with the recent changes, the mission of CES—and, indeed, the entire land-grant university system—is as relevant today as it was in the early 1900s. And I believe it will be as relevant in the year 2014 as it was in 1914, when Congress passed the Smith-Lever Act that established the Cooperative Extension System.

That's a pretty bold statement in these changing times! But I can make such a statement with confidence because CES has always drawn a great deal of its strength from its land-grant university ties. Here in Illinois, CES is blessed with a strong research partner in the Office of Research/Agricultural Experiment Station that's also based in our College of Agricultural, Consumer and Environmental Sciences.

The Hatch Act established agricultural experiment stations in 1877, and research began soon afterward on the University of Illinois campus in Urbana-Champaign. But even though meaningful research was being done, most farmers weren't benefiting from it.

The Smith-Lever Act changed that.

The idea was to "take the university to the people." The vision of Extension's founders went far beyond introducing farmers to innovations such as motorized tractors and hybrid seed corn. These leaders envisioned a system that would help rural—and eventually urban—people to put agricultural experiment station research results to work in building human capital. (See related article "Partnership Illinois," page 27.)

They didn't call it human capital back then, but that's exactly what it is.

If you visit the USDA's headquarters in Washington, D.C., you'll find two large stone arches that cross Independence Avenue. They're named after Seaman Knapp and James Wilson, who were instrumental in establishing and organizing the Cooperative Extension System.

In dedicating those arches in 1937, Congressman A. Frank Lever, coauthor of the Smith-Lever Act, recalled that Wilson and Knapp had believed that "the mechanics of the farm were important only as incidental in the enrichment of the lives of the men and women, boys and girls, engaged in it. Their first concern was with broad humanities—people."

People are still the number-one concern of CES staff throughout Illinois. Illinois CES staff are reaching more people, with more programs, in more places, than ever before. And they're helping those clients deal with complex issues that often can't be addressed with a quick phone call or on-site visit.

In the early days of CES, rural farm and home visits were the foundation of Extension work. That's where the need was, so that's where Extension staff did much of their work. In cases where the clientele and subject-matter warrant it, CES staff still make "house calls." However, in this age of Internet, cellular phones, and voice-mail, many of our audiences—including farmers—require a different approach.

In most cases, Extension education is no longer simply a matter of chatting with the county adviser in the feedlot. Producers (and others) have a mind-boggling amount of information available to them. So Extension educators

and specialists have a responsibility not only to convey information to CES clients but also to help people make sense of information that comes from a wide variety of sources.

Today you'll find Extension educators and specialists working with people at community colleges, in hospitals, and in public libraries—as well as some of the more traditional sites such as Farm Bureau auditoriums and church basements. You'll find CES staff making easy-to-understand information available by mail and over the World Wide Web. And you'll find them developing programs for elementary- and high-school classrooms, where teachers use Extension materials in preparing the younger generation for the challenges of adulthood.

No matter where they are located or what their area of expertise, CES educators and specialists have two things in common: the backing of research-based knowledge from land-grant institutions all across the country and a commitment to improving the lives of Illinois residents.

Those two constants have been a part of the CES tradition since 1914. And I'm confident that they'll be a part of the CES tradition in the year 2014 and beyond.

Dennis R. Campion, interim director of the Illinois Cooperative Extension Service

FLASH

Canned Foods Match Fresh and Frozen in Nutrients

Think fresh fruits and vegetables are nutritionally superior to canned? Think again.

A recent University of Illinois study found that canned produce is just as nutritious as fresh and frozen fruits and vegetables.

Barbara Klein, U of I professor of foods and nutrition, compared the nutritive value of 14 different fruits and vegetables using both the U.S. Department of Agriculture's data bank and nutrition-labeling information. Nearly 84 different varieties and commercial brands were evaluated for nutritional content.

Findings showed that fruits and vegetables stored in the pantry can provide comparable amounts of nutrients to fresh produce purchased in the supermarket.

Consumers' concept of "fresh" produce may need a reality check. What most people think of as fresh fruits and vegetables are actually two to three weeks old by the time they reach the table.

Produce often travels to market under variable temperature conditions for up to two weeks. After purchase, produce may sit in the refrigerator at home for up to a week. During this time, nutrients and quality are gradually diminishing.

In comparison, fruits and vegetables used for canning are usually processed within hours of harvest. The canning process "locks in" the nutritional content and stops deterioration. Even reheating canned foods will not significantly lower the nutrient content.

"The point of the study is to encourage everyone to eat vegetables and fruits, whether fresh, frozen, or canned," Klein said. "Despite the misconception that canned food is nutritionally inferior to fresh, canned produce is a good fit in the five-servings-a-day recommendation for a healthy diet."

Retired Caterpillar CEO Donates $1.5 Million to ACES

A gift of $1.5 million from Lee L. Morgan, retired chairman of Caterpillar Inc., will establish a Morgan Chair in Food and Agribusiness Management at the U of I College of Agricultural, Consumer and Environmental Sciences. The endowment gift will strengthen the faculty, curriculum, and student resources in the area of global business, one of the fastest changing fields in the agricultural sector.

Morgan is a 1941 graduate of the University of Illinois College of Agriculture. He became the chief executive officer of Caterpillar Inc. in 1977 and served in that capacity until his retirement in 1985.

In addition to Morgan's $1.5 million gift, Caterpillar Inc. has pledged $6 million toward "Campaign Illinois," citing the fact that the company employs 540 U of I graduates.

ILLUSTRATION BY BRIAN COOK

Compound Relieves Animals' Phosphorus Digestive Stress

Relief from the inability of some livestock animals to fully digest phosphorus may be on the way.

A new compound has been developed by a team headed by David Baker, professor of animal sciences in the University of Illinois College of Agricultural, Consumer and Environmental Sciences, that could save millions of dollars.

Difficulty in digesting plant phosphorus on the part of some livestock creates severe problems for marine life in streams and lakes polluted by runoff of waste. The indigestion problem also requires producers to use expensive supplements to provide the dietary benefits of phosphorus.

Baker and his team have developed several vitamin D3 analog compounds that increase the digestibility of phosphorus. These compounds eliminate the need for more expensive supplements and decrease the amount of phosphorus in animal waste.

To date, the compounds studied have been effective in poultry. Efforts are underway to develop like compounds for other livestock.

Illinois Farmland Values Rise in 1995

Prices for all grades of farmland and in all regions of Illinois rose during 1995, according to a study by the University of Illinois Cooperative Extension Service and the Illinois Society of Professional Farm Managers and Rural Appraisers.

The study was based on a survey of professional farm managers, rural appraisers, and farmland brokers.

"A majority of respondents in all areas of the state, except the far south, reported an increased amount of land sold in 1995," said Harold D. Guither, University of Illinois professor emeritus of agricultural and consumer economics, who conducted the survey. "The average percentage increases, based on estimates of respondents, ranged from 6 percent in the south-central area to 19 percent in the northwest."

The study also revealed that about 10 percent of the land sold is going out of production for either residential, commercial, or recreational use, Guither added.

Among the other findings were:

- Nearly half of all land sold in 1995 was to settle estates.
- Active farmers made up an estimated 57 percent of farmland buyers, with individual investors accounting for 30 percent.
- Statewide, about 90 percent of all land sold would continue to be farmed for the next three to five years.

Grain-Marketing Device May Set Booby Trap

A complex, relatively new grain-marketing device employed by some midwestern country elevators and farmers threatens to become a very expensive booby trap.

Darrel Good of the University of Illinois Cooperative Extension Service said some estimates place the potential grain elevator losses in the state at $1 billion. Much of these projected losses can be recovered, however, when grain is delivered against the contracts. It is unclear which parties would suffer the most losses.

At the core of the problem is the hedge-to-arrive contract, a device that allows farmers to lock-in a future price for corn. Normally, these contracts present no problems. However, the past year has been anything but normal in terms of corn prices. And as cash prices rise, those investors holding the futures contracts based on the lower prices of 1995 are squeezed.

Seeking to rollover the contracts may in many cases compound the problem and could lead to the potential bankruptcies of some country elevators in Illinois. If that happens, Good pointed out, Illinois taxpayers might end up underwriting some of the losses through the state's country elevator insurance fund. In addition, creditors might have to shoulder some of the loss.

Good advocates a combination of regulatory restrictions on such contracts and greater care on the part of both producers and elevator operators to avoid the problem in the future.

FLASH

Cultural Differences Affect Child Learning

Children of some minority groups may score lower on school achievement tests than Anglo American children, but don't blame their mothers.

According to a recent University of Illinois study, the teaching practices of Mexican American mothers were not inferior to those of Anglo Americans, only different. The study measured the effectiveness of teaching preschoolers to tie their shoes.

Robert Moreno, assistant professor and Extension specialist of applied human development, found that Mexican American mothers actually had better success in teaching this everyday task. The results differ significantly from past studies related to the education of low-income groups and minorities that had shed a negative light on these groups.

The lower scores in IQ and standardized school achievement tests have led some researchers to conclude that the mothers of minority children were ineffective teachers and that these families did not provide their children with sufficient cognitive stimulation necessary for mental development.

Using a new approach to monitor instructional behavior—allowing families to videotape themselves at home—Moreno found that Mexican American mothers used different strategies than Anglo Americans to teach their youngsters how to tie shoes with good results.

These differences may be a key to understanding why Mexican Americans perform generally less effectively in the school setting. Perhaps the academic success is hindered by the discontinuity of instructional practice between home and school.

This research challenges educators to use culturally consistent educational practices such as those that are effective in Mexican American homes.

Degradable Plastic Utensils Are Now on the Research Table

Designing degradable plastics for the food service industry is not a new concept, but researchers at the University of Illinois are offering an added incentive for food service companies: affordability.

Scott Morris, University of Illinois assistant professor of food engineering; L.S. Wei, professor of food science; and Graciela Padua, assistant professor of food science, are creating corn-based plastics that can dissolve in water in one hour.

The plastic material eventually might be used as forks, knives, and other eating utensils at fast-food restaurants. The research is unique in making use of feedstock normally considered low-value.

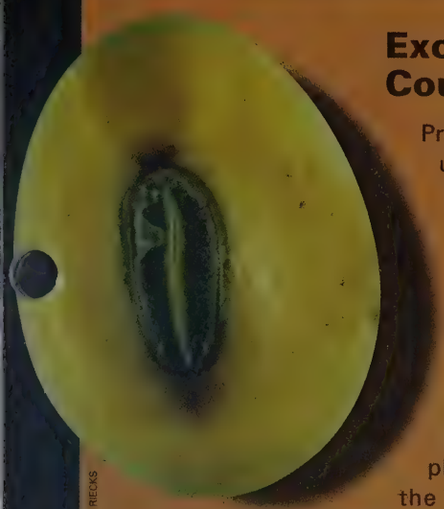
"The goal is to develop plastics that are strong enough to do the job, yet break down quickly in a compost or landfill situation, and are affordable," Morris said. "Synthetic plastics are often produced at various universities, but economics are rarely considered. The usual approach is to take highly refined products that are expensive to process."

Morris and colleagues have produced handmade plastic samples. They intend to produce materials that can be formed using conventional production methods.

The researchers are now determining the balance between structure and usefulness, and biodegradability. In a "real world" situation outside of the laboratory, a degradable plastic sandwich container must hold up when it is used with hot, oily foods.

"We're looking at all the factors involved, from the science end of it to the practical economics applications," Morris said.

Exotic Soybean Germplasm Could Lead to Higher Yields



DAVID RECKS

Producers who have become used to steady increases in the yield of soybeans could face a shock in the future as the genetic base of the U.S. crop continues to narrow.

According to Randall Nelson, curator of the U.S. Department of Agriculture Soybean Germplasm Collection housed at the University of Illinois at Urbana-Champaign, 95 percent of all the genes in the soybean varieties grown in the United States come from only thirty-five ancestral lines.

For varieties grown in Illinois, only three ancestors contribute more than 50 percent of the genes, and only ten ancestors account for 80 percent of the genes.

"This means that, in a worst-case scenario, soybean breeders are crossing parents that are as closely related as brother and sister to produce the next generation of soybean varieties," Nelson said. "Eventually, if the system remains closed to new genes, all the genetic variability for yield will be exhausted."

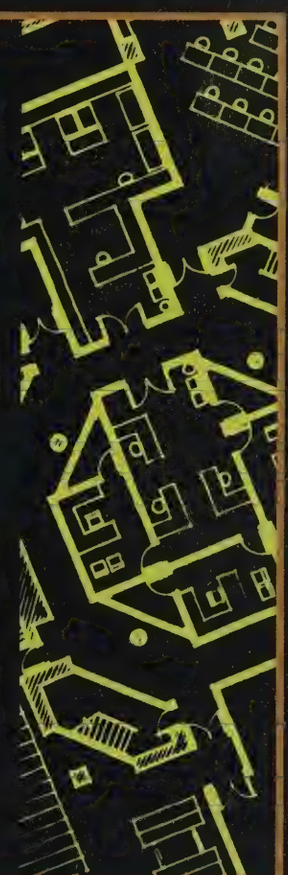
To address this problem, Nelson started a germplasm enhancement program aimed at screening many of the 13,000 soybean accessions in the USDA collection. Those lines that showed a relatively high yield were chosen as parents to develop new experimental lines.

Nelson is convinced that researchers can expand the genetic base of the soybean by incorporating some of these exotic plant introductions. Plans already are underway to release several experimental lines so that breeders can use them as parents to cross into the highest-yielding modern cultivars.

"At this point, we have demonstrated that we can expand the genetic base of our soybean varieties and simultaneously improve yield," Nelson said. "The end result is that we will be better able to utilize the available genetic diversity to continue producing higher-yielding varieties far into the future."

The Corn Marketing Board will provide partial funding for the research project.

Information and Alumni Center Is Closer to Reality



The campaign to raise funds for a new Information and Alumni Center at the College of Agricultural, Consumer and Environmental Sciences went over the $8 million mark this spring thanks to a $1 million gift from Dick and Sally McFarland of Indianapolis.

This is the second $1 million commitment made by the McFarlands to the center's fund-raising campaign.

Other major gifts have included $1 million from the Funk family of Bloomington, Illinois, and $1 million from Florence Odell of Champaign, Illinois. Mrs. Odell's husband, Russell T. Odell, was a soil science professor at the college.

The state legislature approved $1 million in planning funds during the spring legislative session. Groundbreaking is anticipated after the remainder of the state funds are appropriated, likely in the next fiscal year. For information about the Information and Alumni Center, call Associate Dean Lynette Marshall at (217)333-9355.

FLASH

DAVID RIECKS

How Many Pregnant Sows, How Many Expected Piglets? New Test Has Answers

Research now underway in the College of Agricultural, Consumer and Environmental Sciences may provide pork producers with an accurate, relatively inexpensive, easy-to-use method of determining if sows are pregnant and the number of piglets they are carrying.

The new test may bear significant economic implications. Without a reliable early sow-pregnancy test, producers often feed sows more, assuming they will produce more pigs. The test was developed by Professor Janice Bahr; Philip Dziuk, emeritus professor; and two of Dziuk's former graduate students, Shu-wen Chen and William Ruof, all of the University of Illinois. The test could aid in improved sow pregnancy-planning efforts.

"These non-pregnant sows cost at least $1 per day. If producers fail to detect the fact that the animals aren't pregnant well into the gestation period, the swine producers could realize a loss as high as $100 per sow," said Bahr.

The test also provides reliable numbers for the litters. A sow must have seven piglets for producers to make a profit. With only six pigs in a litter, the producer just breaks even. Since about 20 percent of sows have litters of six or less, the availability of methods to detect non-pregnant pigs and those carrying small litters early in the pregnancy could mean significant financial advantage to the producer.

Gilbert Hollis, a U of I Cooperative Extension Service swine specialist, assisted in arranging tests in field settings with participating producers. Results may be in this summer or soon after.

Teens Prepare for Real-World Budgeting

Illinois High School Financial Planning Program

High school graduates who haven't learned how to balance a checkbook and manage their money may be in for a rude awakening when they start out on their own. Good money management is a habit best learned in the teen years.

Thousands of Illinois students now have the opportunity to learn money management in the classroom. The High School Financial Planning Program is a nationwide educational program that is gaining popularity in the state. More than 8,300 Illinois high school students in 153 schools enrolled in the program last year.

Sponsored by the University of Illinois Cooperative Extension Service and the College for Financial Planning, the program teaches teens how to curb spending and save for the future.

After completing the course, many teens establish a savings plan, open a checking account, track their spending, and develop a budget to meet financial goals such as college.

The most important goal of the program is to teach young people how to manage financially on their own after high school, said Vicki Fitzsimmons, program coordinator and U of I Extension family economics specialist.

Financial skills are now more important because teenagers have more money to manage than ever before. In 1994, teens spent about $99 billion—about $63 billion of their own money and $36 billion of family money, according to Teen Research Unlimited.

Reformed Divorce Laws Hurt Some Women

No-fault divorce laws are causing married women to work harder, says a University of Illinois researcher.

In a recent literature review, Jeffrey Gray, assistant professor of consumer economics, found that in states with no-fault divorce laws, divorce causes women to work substantially more hours in the paid labor force without reducing the number of hours spent working at home. Most of the increase in hours occurs before the women divorce.

In many cases, women increase their hours in the workforce to improve their financial situation in the event of divorce, while others work more at home so that their husbands will decide not to seek divorce.

As a result, married women with less time for leisure activities are often left with a decreased sense of well-being. Many women may be worse off because of no-fault divorce laws even though their marriages do not dissolve.

The damage that no-fault divorce can cause women has been documented in several studies. Women received smaller divorce settlements under no-fault statutes. Also, women were more likely to be awarded the family home before no-fault legislation was passed.

Just as the possibility of divorce may affect the amount of hours women work, it may also influence the employment women choose, Gray found in a related study. Wives who are expecting to support themselves in the future may be more likely to enter managerial and professional occupations offering higher salaries.

Mad About Cows!

by V.E. Valli, D.V.M.
Dean, College of Veterinary Medicine
Director, Veterinary Programs in Agriculture, ACES

The "mad-cow disease" in Britain and its impact on beef exports from that country have attracted wide press attention. Although there is no evidence linking the cattle disease to humans, concern has been raised by the media coverage.

It is thought that this cattle disease is caused by a new variant of a "slow virus." A number of slow-virus diseases are known to occur in both humans and wild and domestic animals. Currently, the most well known of these are Scrapie in sheep and Creutzfeldt-Jacob disease in humans. It is currently thought that mad-cow disease may be a variant of Scrapie. Creutzfeldt-Jacob disease in humans occurs worldwide and is universally a rare occurrence.

A few Britons have contracted a variant form of Creutzfeldt-Jakob disease, but with the incidence of the disease in the range of one in a million, it is not worth giving up a good hamburger over.

Despite the fact that sheep brains have been used for human consumption in Britain, the incidence of Britons with Creutzfeldt-Jakob disease has not been greater than the worldwide average.

For many years, Scrapie has been a controlled disease in the United States and Canada. In an infected flock, the animals are destroyed and the owner is compensated. Procedures are similar for handling mad-cow disease in Britain.

Slow-virus diseases, such as mad-cow, which is technically named Bovine Spongiform Encephalopathy (BSE), are unusual in their presentation and behavior. Slow viruses have a slow onset, followed by progression, and are untreatable. These diseases, of which Scrapie has been recognized for centuries, are still not very well understood.

What is new in the recent outbreak is the appearance of a bovine form of spongiform encephalopathy (BSE) that the media dubbed mad-cow disease, primarily in Britain but in other European countries as well. The cause of this cattle disease is not known. Experts suspect that it may have arisen from changes in regulations related to the heat treatment of sheep products used to make fertilizer and animal protein supplements.

BSE has not been reported in the United States. Animals here that were imported from Britain prior to a 1989-instituted ban on certain exports from that country are kept under surveillance.

It is not likely that BSE is being misdiagnosed in the United States. Our food-animal veterinary clinicians have been alerted to look for this disease, as have laboratory specialists. Tissues with neurological diseases of unknown causes are routinely tested.

As a further check, the USDA has conducted a survey of more than 2,000 cases involving brains from cattle suffering from neurologic disease, and BSE, or mad-cow disease, has not been found.

One may confidently conclude that our cattle producers and suppliers continue to provide us with a safe and wholesome source of protein.

BOB REBER

Caring for

"The earth is—a blue dot against the background spangle of the Milky Way galaxy ... [a] blue dot on which all of us and everyone we ever heard of has lived. That blue dot is worth cherishing because it is the only home we have."

Carl Sagan
Commencement Address
University of Illinois at Urbana
May 13, 1990

HELPING PEOPLE ACHIEVE HEALTHIER LIFESTYLES AND RESTORING NATURAL AREAS MAY SEEM LIKE DIVERGENT ACTIVITIES, BUT BOB REBER SEES IN THEM A SIMILAR PURPOSE: CARING FOR LIFE. TO REBER, MEETING THE NUTRITIONAL NEEDS OF A HUMAN OR PROVIDING SUITABLE HABITAT FOR AN UNCOMMON SONGBIRD ARE RELATED ACTIVITIES WITH A COMMON GOAL—THAT OF SUSTAINING LIFE TO THE FULLEST ON THIS BLUE DOT WE CALL HOME.

story *Tina M. Prow*
photos *David Riecks*

PROFILE

PROFILE

FOR A NUTRITION SPECIALIST, BOB REBER SPENDS A GOOD DEAL OF TIME OUTDOORS, AS DO MANY FACULTY MEMBERS IN THE COLLEGE OF AGRICULTURAL, CONSUMER AND ENVIRONMENTAL SCIENCES. THESE DAYS, FACULTY ARE EXPECTED TO TAKE A BROAD APPROACH TO TEACHING, RESEARCH, AND PROBLEM SOLVING. THIS IS THE STORY OF ONE PERSON'S JOURNEY FROM A FARM IN EAST-CENTRAL ILLINOIS TO A MAJOR RESEARCH UNIVERSITY AND THE INSIGHTS HE PICKED UP ALONG THE WAY ABOUT THE INTERCONNECTEDNESS OF NUTRITION, NATURE, HUMAN HEALTH, THE ENVIRONMENT, AND OTHER INTERESTS IN HIS LIFE.

When Reber left the farm in southern Ford County to attend the University of Illinois at Urbana-Champaign, he had no idea he eventually would work with diverse audiences ranging from high-school athletes to premenopausal women. He had grown up with life all around—both domestic and wild. He thought he wanted to work with livestock. Cattle, hogs, chickens, and a prized flock of Suffolk Sheep occupied much of his time. And caring for livestock was incredibly fulfilling.

"Those sheep, along with scholarships, put me through college," Reber recalls. "My 'first love' was raising sheep—and that's where my studies began—in animal husbandry with emphasis on nutrition. I began to realize that livestock were better fed than some of our people. That's when the university's nutritional sciences program and the human aspect of nutrition caught my interest."

After earning a degree in animal sciences in 1963, Reber worked as a research associate for two years, then earned a doctoral degree in nutritional sciences in 1970. He stayed with the College of Agriculture (now the new College of Agricultural, Consumer and Environmental Sciences or ACES) as a nutrition specialist with the Cooperative Extension Service. One of his most popular programs focused on the special nutritional needs of high-school athletes.

"I realized we had a 'teachable moment'—a golden opportunity to promote healthier lives for our youth. Sports nutrition was the perfect vehicle to deliver sound nutrition information to coaches, young athletes, and their parents," Reber relates. Videotapes and circulars were developed for athletes. Workshops were taught statewide for coaches and health professionals. A comprehensive series of articles was written for coaches' magazines. Radio scripts and news releases were developed for mass-media outlets. His efforts to bring research-based information to this audience exemplified the ideal of the land-grant university model.

Reber recalls that in the early days of his career, health professionals were concerned with getting people to choose diets that supplied enough life-giving nutrients every day. Some nutritionists advocated eating fairly high levels of polyunsaturated fat to lower cholesterol, which was linked to heart disease. But some researchers, including Reber, questioned that advice and were beginning to suspect that high levels of polyunsaturated fat might be linked to gastrointestinal tumors.

"The downside of polyunsaturated fat wasn't a concern then, but it is now," Reber says. "Today, many nutritionists recommend that polyunsaturated fat supply no more than 7 percent of the total calories. In addition to a potential link to some tumors, polyunsaturated fat lowers HDL (good) cholesterol as well as LDL (bad) cholesterol."

Although marketing has broadened the array of foods available to consumers today, diet choices are still difficult. People continue to worry about getting enough nutrients, Reber says,

BOB REBER

This single young leaf of compass plant glowed like an eternal flame burning on the prairie at sunrise. It reminded me that prairie survival depends on fire. Only the leaf caught the first light of the autumn sunrise while the background remained in shadow.

Bob Reber

"but the public also is concerned with diet as it relates to disease. For many, that means limiting total fat, saturated fat, or salt. In addition, nutritionists now recognize sedentary lifestyles as the major problem for some people.

"We can no longer consider the diet in isolation from other lifestyle components. That's why the [USDA's] *1995 Dietary Guidelines for Americans* has included physical activity," Reber says. "Increasingly, people are caught in a squeeze: because they are so inactive, they cut back on the amount of food they eat to avoid becoming overweight. As a result, they don't eat enough to supply the needed nutrients.

"The solution is straightforward. Increase physical activity, and eat more nutritious food."

Knowledge and Diet

But does knowing which foods to choose for a healthy diet help people become healthier? Reber is working with Extension educators on the Cooperative Extension Service (CES) Nutrition and Wellness Development Team to measure the impact of their nutrition education efforts on cardiovascular risk factors of three hundred healthy women 30 to 45 years of age.

Working at seven sites around the state, the team divided the women into treatment and control groups. The women agreed to fill out a three-day food and activity diary and to take attitude and knowledge tests. They also agreed to allow the research team to measure their percent body fat, waist-to-hip ratio, and blood pressure. At one location, the study was expanded to include various blood lipid tests and week-long monitoring of physical activity.

During the two-year study, the treatment group received nutrition information from Extension educators in face-to-face programs and by mail. If education has an effect on cardiovascular risk factors, it will show up in changes in the physical measurements and blood data of this group.

"We've always known we could educate people, but does knowledge change behavior, and if it does, does the change in behavior reduce risk? This study will help answer these questions," Reber says.

"The study also is important because of the way it was conducted," Reber adds. The Extension educators are in the best position to immediately

Bob Reber identifying flora for students in his nature class.

apply the results to nutrition education programs. Also, the opportunity to learn research techniques for monitoring and evaluating may help them plan or participate in future research.

Diet and Stewardship

As a nutritionist, Reber is concerned with helping people make healthy dietary choices. But to him, nutrition encompasses more than food on a plate; nutrition is a central theme of the biological world.

The farm boy in him wonders if consumers ever look up from their plates or beyond the grocery store aisles to appreciate the impacts of their choices on agriculture or the environment. "Are we considering the trade-offs we are making when we burn 400 calories worth of jet fuel to fly a 5-calorie strawberry from the Central Valley of California to New York—all in the name of vitamin C?"

He also is concerned that consumers don't realize how dependent their sustenance is on healthy ecosystems. "Our society doesn't understand how closely tied our health is to the health of the land community: the soil, water, air, and all biological species," Reber says. "For example, soil erosion isn't viewed as a long-term nutrition problem of the first magnitude that it is."

Reber's interest in stewardship has an outlet in *The Illinois Steward*, a quarterly magazine of the Illinois Stewardship Advisory Committee. He serves as a managing editor along with Michael Bolin, ACES Department of Natural Resources and Environmental Sciences. The connection Reber makes between diet and health of humans and the health of the land is born out of a holistic view of the cycle of life that sees all species linked together by both cooperative and competitive relationships. This view has its roots in his childhood experiences with nature.

"My early experiences gave me a clear understanding of two critical points essential to my current beliefs: that we are part of nature and that all of creation is to be revered and respected," Reber says. "It seems to me that the best approach to healing the current rift between humans and the rest of nature, and to fostering sustainability of the planet, is one of humble, humane stewardship."

Reber defines this kind of stewardship as one which:

- Realizes humans do not own the rest of creation; rather creation owns us.
- Understands our species is figuratively and literally a part of nature and not apart from it.
- Does not assume dominance, but accepts responsibility for the magnitude and scale of our impact.

- Believes everyone has a responsibility to strive toward sustainability.
- Understands that our species can learn more from the rest of nature than from our own cleverness.
- Embraces an eclectic approach in search of answers—an approach that calls on natural models, scientific disciplines, the arts, philosophy, religion, and indigenous people for guidance.
- Realizes that nurturing "biophilia"—an innate emotional affiliation for the natural world—is key. "The contemplation of the vastness, the complexity, and the beauty of nature fosters a deep humility, a respect, an awe for creation that engenders an attitude that makes striving toward sustainability possible," Reber says.

"It is this tempered biocentric view that I bring to the college that can influence the more anthropocentric dominant view that is espoused by many," he says. "It is not only research findings from hard science but also beliefs and values that will influence our striving for sustainable food and fiber production into the twenty-first century."

Reber's philosophy reflects a commitment to stewardship that can be traced through the generations. One of his treasures is an article that recounts the life of his great-grandfather David Reber, 1851–1918, published in *Youth's Christian Companion* (December 11, 1955). A successful farmer, blacksmith, cabinet maker, orchardist, and beekeeper, the elder Reber also was an accomplished naturalist. "Besides, he knew the birds, wild animals, native berries, and fruits of the area," Melvin Gingerich wrote in the article.

PHOTO COURTESY OF BOB REBER

Reber, as a teen, with one of his prize-winning ram lambs.

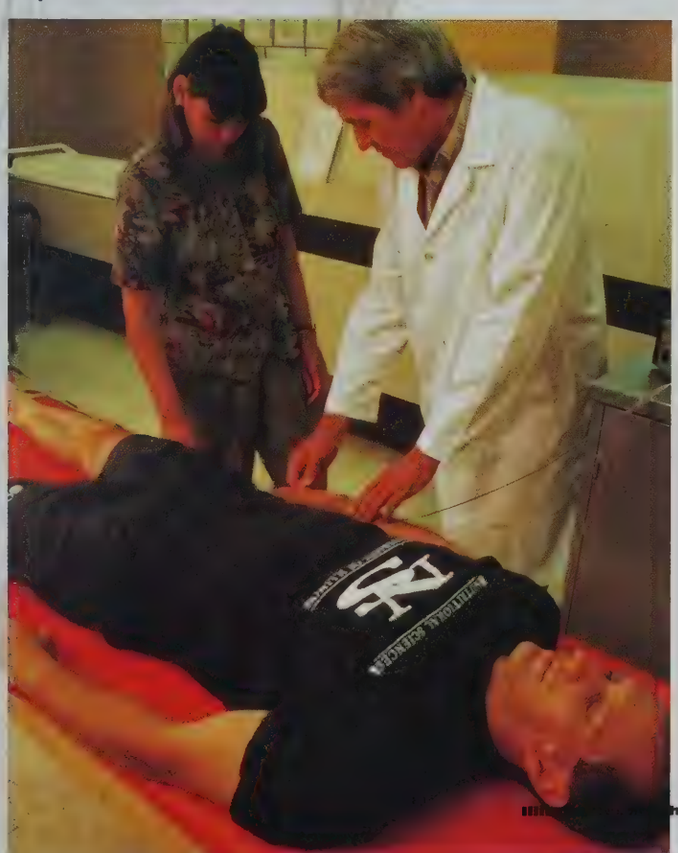
Another of Reber's treasures is a worn but remarkably well preserved book on woodland wildflowers published in 1945. Seen in a local dime store, the drawings entranced him. "It cost 25 cents, which wasn't easy for me to come by then, but Mom bought it for me," he recalls. "I couldn't even read then, but I carried it with me over the years."

Reber's parents nurtured his affinity for nature through example. On the farm, taking care of living things—whether raising crops, tending livestock, or rescuing pheasants from an ice storm—was a way of life. "Caring for life was a privilege and a calling; it gave us purpose and identity," he recalls.

"Not a day went by without some observation from my parents about life around the farm," Reber says. "We'd talk about the fox pups we saw coming out of the den or the dog-tooth violets beginning to bloom. We worked harder than you can imagine, but we found time for picnics in the woods and took pleasure in the things around us." One of Reber's earliest memories is being held by an uncle so that he could dangle and splash his feet in the Sangamon River.

In the family tradition, Reber has made room in his life for nature and stewardship. He cares for the Howard Thomas Memorial Nature Preserve and other prairie areas

Donna Falconnier, an Extension nutrition and wellness educator, is learning from Bob Reber how to measure Greg Paul's percentage of body fat. Paul is a postdoctoral research associate in the Department of Food Science and Human Nutrition.



Reber captures *Sun Singer* against a moonlit sky over Allerton Park near Monticello.

near Paxton. His Project Wild One Hundred class is designed to show the natural areas unfold over three seasons and help participants rekindle their love of nature. Reber counts the Sunday afternoon explorations of the natural areas as a treat for himself as much as for the class participants.

"It's important to get out and converse with the rest of nature, to stay connected. I think there's a danger that over time we may have biophilia trained out of us. If we are not careful, we develop biophobia, an aversion to nature that presumes only human interests and activities are important," Reber says. "But in the long term, culturally and spiritually, it is in our own best interests, as well as the rest of nature, to cultivate and celebrate our connections."

Tina M. Prow is a communications specialist in the college's Information Services office. She is a recent graduate of Reber's class in nature studies.

Reber's Reading Corner

The following are publications that Bob Reber recommends for anyone interested in nature or nutrition, which are two of his greatest interests in life.

The Illinois Steward. A quarterly magazine published by the Illinois Stewardship Advisory Committee. Michael Bolin and Robert J. Reber, Managing Editors, College of Agricultural, Consumer and Environmental Sciences, University of Illinois, Urbana-Champaign.

Aldo Leopold, ***A Sand County Almanac—And Sketches Here and There,*** Oxford University Press, New York, 1987.

Wes Jackson, ***Altars of Unhewn Stone—Science and the Earth,*** North Point Press, San Francisco, 1987.

Wendell Berry, ***The Gift of Good Land,*** Gnomon Press, 1981.

E.M. Hamilton, E.N. Whitney, and F.S. Sizer, ***Nutrition Concepts and Controversies,*** West Publishing Co., New York, 1991.

John Hay, ***A Beginner's Faith in Things Unseen,*** Beacon Press, 1994.

Peter Sauer (ed.), ***Finding Home: Writing in Nature and Culture from Orion Magazine,*** Beacon Press, 1992.

Clarence Mitchell, ***River Hill Soliloquy,*** College of Agriculture, University of Illinois, 1986.

Barry Lopez, ***Of Wolves and Men,*** Scribners, New York, 1978.

A Place of Discovery

Attend a student club meeting.

Tour a beef production facility.

Discuss your views on controversial issues.

Explore career paths.

Read and send e-mail messages to classmates in cyberspace.

Does this sound like the average college lecture course? Hardly. The Discovery Program for new students in the College of Agricultural, Consumer and Environmental Sciences is anything but typical.

by
Lisa Sheppard

ACES 100 Is Part of the College Discovery Program

The Discovery Program is, in turn, part of a campuswide initiative to help first-year students in their transition to the intellectual life at the University of Illinois at Urbana-Champaign (UIUC).

Discovery courses are unique—many classes are held just one or two hours per week. Students meet in small groups. The courses are taught by faculty, not by graduate students.

All first-year students in the College of ACES must take ACES 100, "Contemporary Issues in Agricultural, Consumer and Environmental Sciences." This was the first Discovery course offered to any students on the UIUC campus.

ACES 100 introduces new students to the college, the campus, the faculty, and each other. Together, they discover contemporary issues facing food, human, and natural-resource systems. Lecturers cover topics ranging from ethics and values to nutrition and optimal health, water quality, animal rights, and biotechnology to cultural awareness, family issues, and food safety.

The real strength of the Discovery course is the break-out discussion groups, where students meet with faculty to air their views on controversial issues taken from the lectures. A global perspective on society's problems is presented.

Rebecca McBride, assistant dean of the college and co-instructor for the course, leads many discussions. "Students tell us that the discussion sessions are the way to go. They provide a less intimidating atmosphere for new students."

A "Systems Approach" Helps Young Adults

Students study contemporary issues of five systems: the human social, the global, the environmental, the food and fiber, and the science and new technology system. While they are encouraged to explore the interconnectedness of various components in each system, students also explore their own feelings and beliefs about issues.

Discovering the ACES Faculty

Discovery courses introduce students to a world view on important issues affecting their lives. But that's not all they do. The courses also introduce new students to the faculty in the college and promote mentoring relationships. The faculty-student interaction is a critical component of the Discovery course, according to Wayne Banwart, assistant dean and co-instructor of ACES 100.

"This program dispels any myths that the faculty don't care about the students," he said. "The twenty-four faculty involved in ACES 100 in 1995 were not compensated for the course, yet they took the time to prepare for discussions and lectures, and made the effort to learn students' names. Students feel that they are not just a number.

"Since students are freshmen, the faculty also do a little bit of mothering and fathering—a little nurturing. And the students appreciate that," Banwart said.

Discovering Campus Resources

Where are the library resources to research this topic? What clubs are here? What career paths might I take with this major?

Faculty in the ACES 100 Discovery course answer these and other questions incoming students might have. This may be the only course in which students are required to attend a club meeting on campus. All students are also assigned to find specific publications in the undergraduate library. This exercise familiarizes them with the college's and university's outstanding library resources.

These days, new collegians are already thinking about the years after graduation, including job possibilities. To help guide them, this Discovery course provides a lecture on career opportunities in the twenty-first century.

Students get acquainted with the Career Services Center on campus and the Career Development and Placement Office in the College of ACES.

Discovering the Internet

In this technological age, students must learn about computers, and the Discovery Program is the best place to start. ACES 100 is an acknowledged leader on the UIUC campus for introducing students to networking, according to John Schmitz, director of the Agricultural Instruction Media (AIM) lab. In the past two years, the course has introduced five hundred students each year to the World Wide Web and e-mail.

Students participate in a hands-on learning session on using the Internet and take an Information Highway Driver's License Test to show they have learned their rights and responsibilities when cruising the net.

The Discovery home page on the World Wide Web provides information that complements classroom lectures and discussions. Students check their e-mail for news from their instructors and messages from their classmates.

To check out the College of ACES Discovery home page on the World Wide Web, go to the following location: http://gopher.ag.uiuc.edu/AIM/Discovery/.

"We know we can increase the efficiency of teaching and learning by providing course materials on-line and by allowing students to easily communicate with their classmates and instructors on-line," said Schmitz. "Routine class business can be conducted more efficiently this way. Then, when students visit their instructors face-to-face, time is freed up for discussions of course topics and careers rather than, 'When is the next assignment?'"

Schmitz predicts that in the future more instructors will create "virtual classrooms" for their students. For example, the College of ACES now has fifty classes on the Web, which is the highest number of any college at UIUC.

"There are certainly advantages," said Schmitz. "You can tell students, don't bother giving your instructor the excuse that you lost the syllabus, because it is probably on the Web."

Discovery Catches on Across Campus

Although the College of ACES developed the first Discovery program at the university, the Provost's Office created its own Discovery program in 1994.

Unlike the ACES 100 course, the campuswide program is an elective course rather than a requirement. Campus courses can take different formats, but each course must be faculty-taught, interactive, and limited to no more than twenty first-year students.

The program has been highly successful, according to Susan Gonzo, associate vice chancellor for academic affairs and instructor for one of the courses.

Like the ACES Discovery courses, active learning is readily used in UIUC's campuswide programs. Many faculty are abandoning the lecture format and using computer conferencing and group discussions instead.

"This is the perfect opportunity for faculty to try out different approaches to teaching, since the classes are limited to twenty students," Gonzo said. Teachers need small classes if they really want to experiment, she added.

Students Give Voice to Discovery

As for the students, they have given positive feedback on the campuswide program. Attendance tends to be higher than in large lecture courses.

They are worried about getting lost in the shuffle at such a large university. But students say Discovery professors actually care.

Here are some accolades students gave the program:

- "I liked the comfortable atmosphere. It made me want to come to class because I knew the instructor and the classmates were expecting me to come."
- "We did more than just get lectured at during this class. It was, in a way, like our own little family."
- "It was an awesome learning and growing experience."

Lisa Sheppard is a communications specialist in the college's Information Services office.


FUTURE WAVES OF

Primitive farmers often looked to the stars to track the progression of the seasons. Today farmers are once again looking up to the heavens, only this time with a high-tech twist.

by *Doug Peterson*

Don O'Neall studies a soil map on the GPS monitor in his tractor. By using GPS to map soil fertility levels, O'Neall's tractor equipment can automatically change fertilizer application rates "on the go" to meet specific needs in a field.

Farmers are looking to satellites, which allow them to pinpoint the location of their equipment in the field with impressive precision. Armed with this information, computers on board their tractors can map the fields according to a variety of key features.

Take Don O'Neall's farm near Downs, Illinois, for example. With his satellite link-up, he is able to map soil fertility levels across his fields. His equipment can then be programmed to automatically adjust the application rate of phosphorus, potassium, and nitrogen according to the specific needs of the soil. The adjustments are made "on the go" as the applicator crosses each field.

When O'Neall plants, his computer can create a map of seed populations throughout each field. Then, when he cultivates and harvests, his equipment can count the plants that have grown and can map stalk populations. This allows him to compare the seed population with the actual number of plants throughout the field. He also uses a satellite link-up to map yields at harvest and to tailor his pesticide applications to specific conditions.

Some of the innovations on O'Neall's farm are still rare sights, such as a row guidance system that allows his equipment to essentially steer itself. But the use of satellite link-ups is spreading across agriculture, and computers are entering the heavy-machinery world of farming in ways that few could have foreseen even ten years ago. In fact, it's difficult to pick up a farming magazine these days without some reference to such high-tech trends.

What's Really Possible?

The interest is so high that O'Neall fears the expectations are sometimes unrealistic.

"There's a lot of hype in this area," he says, "and there are a lot of over-expectations among producers. Some people are selling more hope than product."

John Hummel, an agricultural engineer with the USDA Agricultural Research Service, has similar sentiments. He says interest is so great that there is the risk that the technology and supporting research won't be able to keep pace with it. That is why UIUC and other land-grant universities across the country are stepping up research in this area.

Any basic understanding of these new systems begins with basic terminology. "global positioning systems," or GPS, is the name given to the satellite linkup that allows farmers to locate specific points on the land and to map fields. Using these maps to control pesticide or fertilizer application rates on the go is commonly called "variable rate application," though it also answers to a variety

of other names: site-specific application, prescription farming, or precision farming, to name a few.

GPS Catches On with Illinois Farmers

But whatever name it goes under, business in this area is booming. Illini FS provides custom fertilizer applications for farmers in the Illinois counties of Champaign, Douglas, Edgar, and Clark, and it was one of the first businesses in the nation to offer GPS-based soil testing and variable-rate applications on a large scale. Karen Metzger, agricultural information manager for Illini FS, says that when they began this venture in 1991, their goal was to do GPS-based soil testing on 40,000 acres within five years. They met that goal in two years, and the numbers keep skyrocketing.

During the past five years, Illini FS has used GPS technology to test soil on 230,000 acres. On 80 percent to 85 percent of these acres, Illini FS went on to apply fertilizer and lime using variable-rate applications.

In addition to soil testing and fertilizer application, the other major use for GPS technology so far has been yield monitoring. As Hummel puts it, "Yield sensing with GPS is in full bloom."

Yield monitors estimate grain flow into the combine's grain tank every one to three seconds. By combining this data with GPS information on the equipment's position, farmers can develop a map of yields throughout a field.

Equipping a combine with a yield monitor can cost about $6,000 to $7,000—a price tag that includes the GPS equipment. But, as farmer Doug Harford explains, "On a $170,000 machine, that's almost like purchasing a radio with a new car."

Because of the relatively low cost and high interest in yield monitors, many analysts believe it is inevitable that they will become a standard feature on combines in the near future. The question now is exactly how to use all of the information that the yield monitors churn out. A yield monitor provides a detailed map of how yields fluctuate within a field, but farmers still need to do detective work on what caused the fluctuations.

"It's all about problem solving," says Harford, who farms near Mazon, Illinois. "And the solutions can sometimes be elusive."

Sometimes, but not always. Harford has already used his GPS-generated yield maps to solve a couple of potentially costly puzzles. In one case, his computer-generated yield map showed that he was getting 70 bushels per acre in one end of a 160-acre soybean field, whereas yields at the other end were down to 50 bushels per acre.

GPS: How It Works

Global-positioning systems (GPS) tell you where in the world you are—with an accuracy of anywhere between 6 to 20 feet in diameter. To do this, it all begins with satellite signals, which are transmitted to an antenna on the roof of your tractor or combine.

However, satellite signals alone cannot locate your equipment's position in the field with any great accuracy because the U.S. Department of Defense has deliberately built errors into the signals—for security reasons. It did not want to give an adversary the opportunity to use the satellite signals to target U.S. sites with pinpoint accuracy.

Therefore, to correct the errors in the signal, you need to receive a second signal from a ground-based station. This system, known as "differential GPS," creates a triangle of signals. **(Continued on the next page.)**

PHOTO DAVID RECKS / DIGITAL EFFECT: ALEX MOORE

Receiving the Satellite Signal

1. **The satellites send signals to the ground-based station, as well as to the tractor.**
2. **The ground-based station sends a "correction signal" to the tractor.**
3. **Equipment on the roof of the tractor receives the satellite signals as well as the correction signal.**
4. **The tractor's on-board GPS receiver puts all of this information together to pinpoint the area of the field that the equipment is passing over.**

Receiving a Correction Signal

Farmers have three basic ways to obtain a correction signal:

Obtain a signal transmitted by Coast Guard stations. This signal is free, but the farmer's receiver must be located within 250 miles of a Coast Guard station. Stations are strung along the coasts and up the Mississippi River.

Receive a signal that is broadcast on the side band of a commercial radio station signal. A farmer must pay a subscription fee for this signal. The signal has about a 50-mile range and can be more susceptible to interference than other signals.

Subscribe to a service that provides a correction signal. One popular system transmits its correction signal through its own system of satellites. This makes it possible to receive the correction signal no matter what your location in the United States.

Operate your own ground-based station. Developing your own station to transmit the correction signal can be costly. In addition, the range of such a signal tends to be limited to about 12 to 15 miles.

Greater Accuracy with Kinematic GPS

Most farmers using GPS connect their equipment to standard systems that can locate their position on the field within a diameter of about 6 to 20 feet. But a newer system, known as "kinematic GPS," can locate your position with even greater accuracy—within a 1-foot-diameter circle.

Kinematic GPS boosts accuracy by measuring the number and length of the radio waves being sent to the tractor by the satellite. It is more expensive than standard GPS, but the price is coming down.

Sources: Carroll Goering, UIUC agricultural engineer; and John Hummel, UIUC agricultural engineer, USDA Agricultural Research Service

Harford does extensive scouting, so he didn't think soybean cyst nematodes could be causing the yield reduction. But on the advice of a crop consultant, he tested the soil in the low-yielding area anyway and, sure enough, he found nematode problems.

Can GPS Help the Environment?

In addition to the problem-solving benefits of the new technology, producers and industry representatives see the potential for environmental payoffs. Without GPS and variable-rate technology, farmers generally tailor rates to the greatest needs in a field, which means that some areas may receive more fertilizer or pesticide than necessary. By varying the rate of chemical application according to specific needs in a field, the applications will be more precise and possibly less total product will be put down.

However, there has been little research on the environmental benefits of variable-rate application—which is why the university has initiated a study to do just that. (See "Research for Tomorrow.") It is conceivable that GPS technology could eventually be used to map an array of environmental factors throughout a field, such as proximity to streams, susceptibility of the soil to erosion, or depth to groundwater. The computer could take these factors into consideration as it adjusted application rates of fertilizer and pesticides.

So far, the major use for variable-rate technology has been for phosphorus and potassium application, which does not present clear-cut environmental benefits, says Rob Hornbaker, a UIUC agricultural economist. Phosphorus and potassium tend to move into surface-water supplies by hitching a ride on eroding soil. Therefore, variable-rate application is most likely to reduce the amount of phosphorus and potassium reaching surface water if it lowers application rates on erosive areas of a field.

Unfortunately, that is not always the case, notes Hornbaker. Variable-rate application can sometimes increase application rates in certain parts of the

field; if those areas happen to be highly erosive, the amount of phosphorus and potassium reaching surface water could actually increase.

If variable-rate application becomes more widely used for applying nitrogen and pesticides, the environmental benefits could be much more significant because those are two of the most serious contaminants.

The Economics of Using GPS

Along with the engineering questions that surround some of the potential uses for variable-rate application, there is the bottom-line question: Does it pay?

It all depends on what you're using it for. In January 1995, Hornbaker and his colleagues completed a study that determined which field conditions made it profitable to apply variable rates of phosphorus and potassium. Essentially, they found that variable-rate application becomes more economical as the average fertility level and the fertility variability in a field increased.

Although it may be possible to gauge the economic returns of using GPS to apply fertilizers or pesticides, some believe there is a lot about the technology that cannot be reflected in a price tag. Yield monitors, for one.

"Does information gathering pay?" says Harford. "That's like saying, 'Does a college education pay?' We're learning. It's a long-term investment."

Harford is quick to stress that his results with GPS and the testimonials of other farmers are "experiences, not experiments." Experiences are not the same as the controlled research that needs to be done on this technology, and they should be viewed with that in mind.

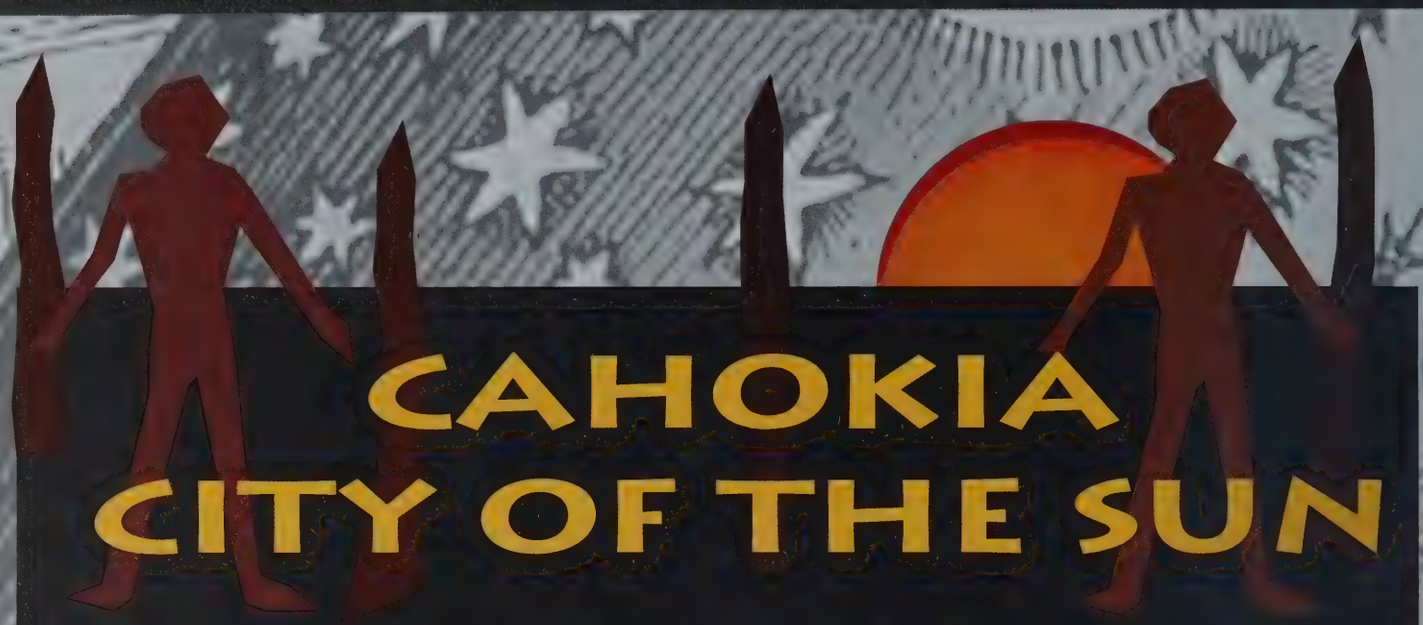
"Without a yield monitor, a lot of our problem-solving work would not be possible," he says. "But I still consider this an experience, not an experiment. And as the technology develops, I'm planning to get as many experiences with it as possible."

Doug Peterson is a communications specialist for the college's Information Services office.

Research for Tomorrow

Researchers at the UIUC are approaching global positioning systems (GPS) and variable-rate technology from a variety of angles:

- **UIUC researchers have designed and patented a sensor that predicts the amount of organic matter in the soil—an important factor in setting pesticide rates. The sensor could be used with GPS to alter pesticide rates on the go.**
- **Agricultural engineers have tested a sensor that could be used with GPS to map nitrate concentrations in a field and adjust nitrogen applications accordingly.**
- **UIUC researchers are working on equipment that sends pulses of light across a corn row to count and measure plants. Used with GPS, this device could be used to map plant populations.**
- **Agricultural engineers plan to use GPS in programming self-steering equipment.**
- **A 1995 study found that variable-rate technology generally became more economical as two factors increased: the average fertility level in a field and the variability of fertility levels.**
- **UIUC researchers have just begun a three-year study that will look at both the environmental and economic impact of variable-rate technology.**
- **Researchers are analyzing the economics of collecting soil test samples from 1-acre grids in a field. GPS-based soil samples are usually collected from 2.5-acre grids.**



CAHOKIA CITY OF THE SUN

Many ancient societies looked to the sky not only as a source of spiritual enlightenment but also as a practical tool. Astronomical objects helped our agrarian ancestors time the planting and harvesting of crops, and the ancient peoples of Illinois were no exception.

A sophisticated culture known as the Mississippians inhabited the city of Cahokia, Illinois, from about A.D. 700 to 1500. The Mississippian people's wealth and power at Cahokia were based on maize agriculture and long-distance trade. Located in the fertile Mississippi River Valley near the confluence of the Mississippi, Missouri, and Illinois rivers, the Cahokia site was perfect for both enterprises.

The Mississippian culture, including the characteristic mounds they built, stretched from Wisconsin to Mississippi and from Florida to Oklahoma. At Cahokia Mounds State Historic and World Heritage Site lies the most impressive archaeological relic of their existence. The Mississippians at Cahokia built as many as 120 earthen mounds—up to 100 feet tall—in the area. Some of the mounds were used for burials, but most were for ceremonial activities for the living.

The peak of Mississippian society at Cahokia was A.D. 1100 to 1200, when the city covered nearly 6 square miles. The city's estimated 20,000 inhabitants made their homes in houses arranged in rows around open plazas, and they grew their main crops in agricultural fields lying outside the city.

According to writings on the subject by E.C. Krupp, director of the Griffith Observatory in Los Angeles and an expert on ancient astronomy, "Systematic astronomical observations probably were performed at Cahokia to coordinate the complexities of urban life, to unify the community through public ceremony, and to maximize the yield of increasingly intensive cultivation."

Experts such as Krupp speculate that early residents of Cahokia used a solar observatory known as the "American Woodhenge" to observe astronomical events such as the solstices and equinoxes. So named because of its similarity to the English Woodhenge (a prehistoric site of concentric post rings near the well-known Stonehenge site in England), the American Woodhenge at Cahokia is an arc of postholes. When the posts were in place, the site "provided sunrise alignments for both solstices and the equinoxes between a post slightly offset from the center of the ring and posts on its perimeter. Another pair of posts defined the circle's north-south axis," said Krupp.

The public can visit the 2,200-acre Cahokia site, which includes 65 preserved mounds, the Woodhenge sun calendar, and a new interpretive center. The site is open daily 8 a.m. to dusk, and the interpretive center is open daily 9 a.m. to 5 p.m. (except some major holidays).

For additional information, write to Site Manager, Cahokia Mounds State Historic Site, P.O. Box 681, Collinsville, IL 62234, or phone (618)346-5160. To obtain information on the Internet:

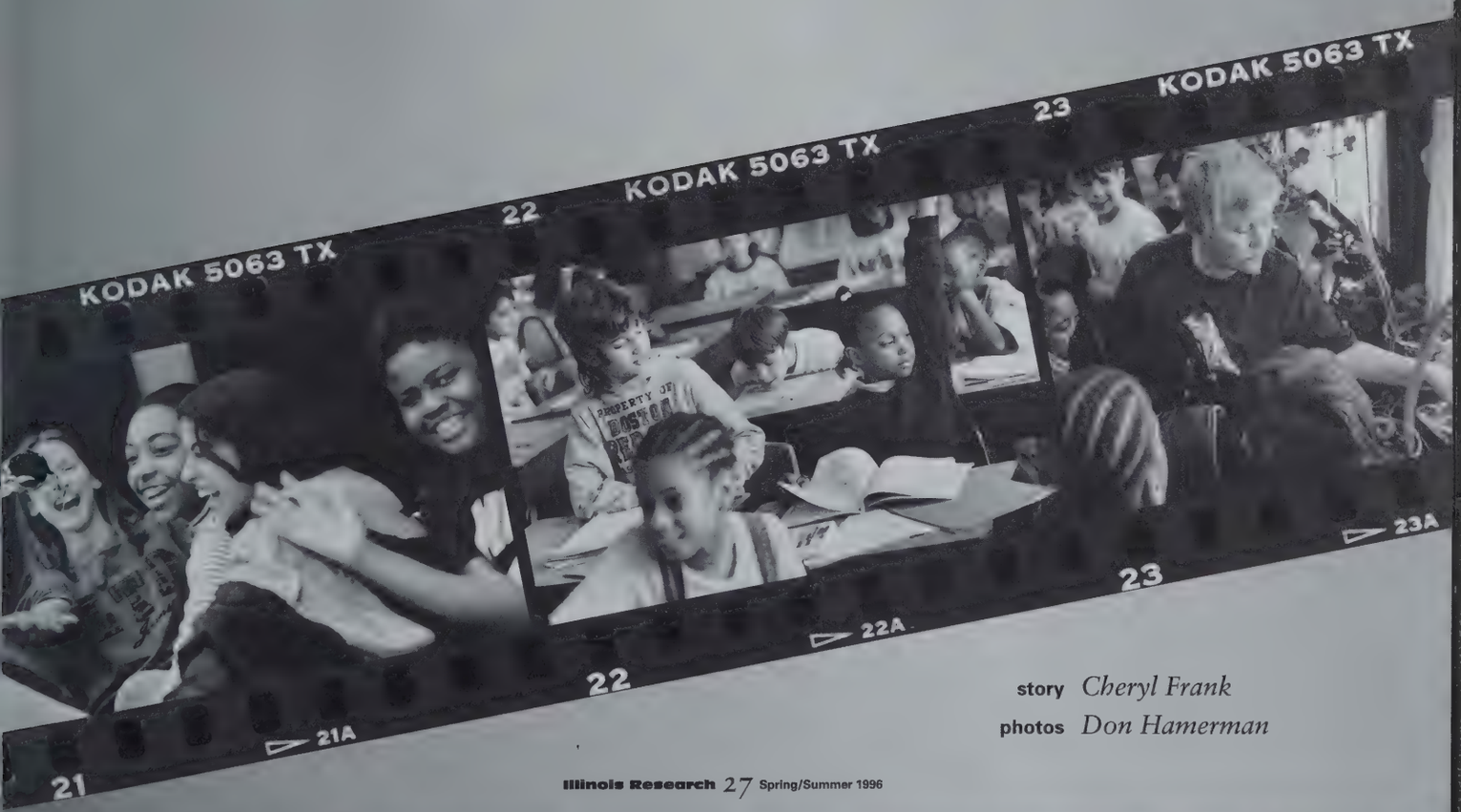
http://medicine.wustl.edu/~kellerk/cahokia.html

Nancy Nichols is the new communications director for the National Association for Interpretation, an organization devoted to the profession of natural and cultural history interpretation.

ILLUSTRATION BRIAN COOK / MARISA MEADOR

4-H PROJECTS ARE EXAMPLES OF THE KIND OF COOPERATION AND ENERGY THAT THE PARTNERSHIP ILLINOIS CAMPAIGN IS BRINGING TO PUBLIC ATTENTION.

PARTNERSHIP ILLINOIS



story *Cheryl Frank*
photos *Don Hamerman*

Molding yellow clay into a giraffe, 11-year-old Gus Morris ponders the questions, "What does 4-H mean to you? What do you like to do here?"

"A lot of stuff . . . Love . . . Fun . . . Meeting my friends," he says. He looks up and smiles. Gus and dozens of children attend 4-H at the Westside Health Authority facility in Chicago. 4-H is the statewide youth audience program of the University of Illinois Cooperative Extension Service (CES).

Thanks to 4-H, Gus has a safe place to learn and grow. The neighborhood elementary school is closed summers, and the park, only six blocks away, is a regular site of gang activity.

Down several tables from Gus are Antoinette Malone, 8; Alicia Jett, 11; and Kenyetta Luckett, 8. They are in a puzzle contest. They say 4-H means to be kind and love others, and not to fight. "It's nice to be here," observes Alicia.

Children in the club identify with 4-H volunteer Tony Bell, who makes his living as a social worker with Chicago Head Start.

A soft-spoken African American man, Tony, of Liberty, works in this west Austin neighborhood. His 4-H circuit comprises the Austin, Woodlawn, Chatham, Oakland, and Kenwood areas.

This warm July morning, Tony stands before a line of tables watching over the children. They talk, laugh, cut out designs, work puzzles, and blow bubbles. Their main learning activity earlier today was building communication and social skills for leadership.

Children learn about sports nutrition and general nutrition. Kids explore their own heritage through foods they eat and learn about foods of other people. They learn to complete projects, handle emotions, and develop self-esteem.

All the children wear the 4-H T-shirt with the winning design from a citywide kids' competition. The beige shirt has a giant green 4-H, green clovers, the CES logo, and the words "Head, Hands, Heart, and Health." 4-H says "Give to Life & Life Gives to You."

The walls too have green clovers with children's drawings of their favorite 4-H activities. Kids arrive here on Tuesdays, Wednesdays, and Thursdays. As 4-H club members, they receive the benefits of state of Illinois and University of Illinois cooperative efforts. This strength is the capstone message of the U of I campaign, "Partnership Illinois." (See the "Partnership Illinois" sidebar.)

Funds for the Austin club come from various sources—the Frank Thomas Foundation, the state Department of Children and Family Services, and the Chicago Department of Human Services, as well as CES. Funds also come from Austin's city-funded Youth-Net Program, which has other local, state, and federal support.

Earlier, the children recited the 4-H pledge of good conduct and citizenship, Tony tells Charlotte Fernandes. She is Extension assistant in the Cook/Chicago South Extension Unit, working with the 4-H program citywide.

4-H reaches children around the state with tried-and-true "classic" teaching methods pioneered since the 1920s.

Even some teens accused of serious crime and detained at the Cook County Temporary Detention Center southwest of the Loop are served by a fledgling 4-H club. They grow potted plants and raise flowers to beautify the place. The center is a massive, white, concrete structure, where the driving 4-H force is center staffer and 4-H volunteer Melvin McBride. Donating his time to 4-H has recently become more difficult now that he works the "graveyard" shift as a center employee.

Monica Collier, a facility supervisor with bundles of keys on her belt, says, "These kids in here are still kids. They need somebody to care." She and Melvin are hoping for increased center backing.

Today's 4-H is a tapestry of urban-rural participants, sites, arrangements, and activities—in the partnership spirit.

Josiah Davis, 10, is learning to garden from 4-H staffer Eva Woods, who teaches children at several schools how we get our food.

Kids learn to grow vegetables and flowers. This day, she supervises children at Jacob A. Riis Elementary School on Chicago's southside. Josiah planted tomato and onion. "It's fun," he asserts.

The kids are also planting a flower called dusty miller. "Don't use the soil near the rocks," Eva tells Josiah. She has enjoyed doing this work for more than a decade.

This garden, on the Riis grounds, has borders donated by the Chicago Park District. The kids are tending their peppers, beets, beans, cabbage, onions, lettuce, carrots, corn, and flowers.

"You planted this plant too close to the tomatoes," Eva calls to the children. "I can teach them better when they make mistakes and see the results," she explains.

Eva spends time in several neighborhoods and embodies community spirit. In this area, many kids live in subsidized housing. Without the 4-H garden, they probably wouldn't garden at all, she says. "It's beautifying and gives extra food."

Treneca Franklin, 7, attends first grade at Riis. She helped plant tomato, onion, parsley, and string bean. She likes beans and radishes. First-grader Larry Steele, 8, chimes in, "We are really learning!"

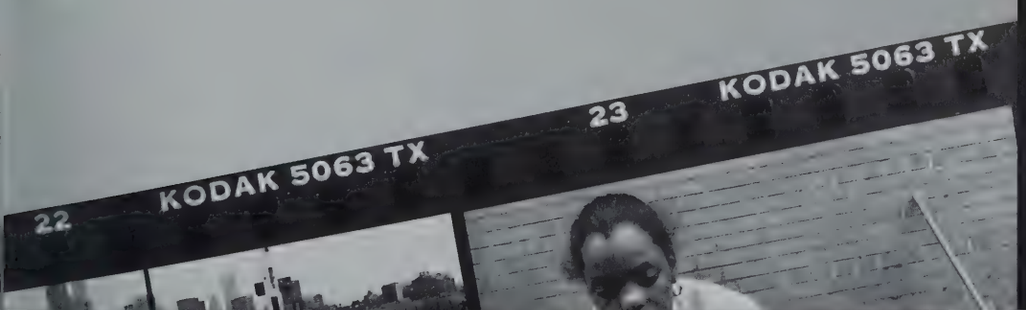
Jeff May, wearing a sport jersey and tennis shoes, enjoys eating. He has taped-up glasses and an outgoing manner. The 10-year-old third grader's favorite subjects are "the 4-H garden and math." He anticipates eating greens and salad.

4-H volunteer Jerome Wade, 15, graduated from Riis. He wants to be an architect and football player.

Inside Riis—an imposing, dark-brick building with mustard-toned walls and halls lined with dark-wood borders and old lockers—it is a little stark and needs some repair. Bright, multi-cultural theme posters made by the children tell how people should respect each other, develop good character, and care for animals and the environment.

June Cooper, the assistant principal and a 4-H volunteer, has been at Riis two years. She wants more 4-H presence in the school. "4-H is connected to science, to social studies, to culture. It's connected to school and family. That's what I like about it."

Cheryl Frank is a communications specialist in the college's Information Services office.



"Partnership Illinois" Packages the Power; Joint Projects Need Public's Support

The Illinois 4-H Program, known by its emblematic perky green clover designed to bring a smile to kids and their parents, is a "blue-ribbon" piece of work.

When it comes to exhibiting a durable and successful state and university partnership to guide and teach children, 4-H has one of the longest and best track records.

"Projects run by the U of I Cooperative Extension Service receive funds from the state government, and also help from the federal government and local communities and schools. So, yes, 4-H projects are examples of the kind of cooperation and energy that the 'Partnership Illinois' campaign is bringing to public attention."

So says Mary Kay Munson, Ph.D., interim director of the Illinois 4-H Program.

Carol Menaker, U of I director of communications, agrees. "Just about everything CES does follows the Partnership Illinois program." Partnership Illinois is the name of the initiative of the U of I at Urbana-Champaign designed to inspire new relationships between the university and its constituents and to talk about all the university's partnerships providing citizens with services and resources.

The university is attempting to strengthen and focus its efforts to best serve the needs of the state. Governor Jim Edgar designated September 9 as "Partnership Illinois Day."

The U of I invites its faculty, its advocates, and those served by university programs to recognize and strengthen these partnerships, and establish the university as central to the state's economic well-being and quality of life.

University of Illinois at Urbana-Champaign
Office of Research/Agricultural Experiment Station
211 Mumford Hall, 1301 West Gregory Drive
Urbana, IL 61801

"The earth is—a blue dot against the background spangle of the Milky Way galaxy ... (a) blue dot on which all of us and everyone we ever heard of has lived. That blue dot is worth cherishing because it is the only home we have."

Commencement Address
University of Illinois at